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ABSTRACT

This guide offers information and procedures necessary to train electronics engineering technicians. Discussed first are the rationale and objectives of the curriculum. The occupational field of electronics engineering technology is described. Next, a curriculum model is set forth that contains information on the standard electronics engineering technology curriculum, electives, and related courses. Each course description contains some or all of the following: a discussion of the content of the course, a list of course prerequisites and co-requisites, credit hours to be awarded for completion of the course, a course outline, suggested student laboratory activities, a list of student competencies addressed in the course, and a list of recommended texts. Course descriptions are provided for 5 courses in the social and related sciences, 6 courses in mathematics and science, and 19 technical courses. Concluding the guide is a section dealing with equipment needed to implement the curriculum. Appendixes to the guide contain guidelines for implementing a problems course, a list of technical organizations and societies and a list of technical publications and periodicals. (MN)

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ELECTRONICS ENGINEERING TECHNOLOGY CURRICULUM

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MEMORANDUM

TO: The People of Georgia

FROM: R. E. Morrison, Jr., Ph.D.
High Technology Coordinator

RE: Preface to the Engineering Technology Curriculum

In the past two years, Georgia has taken the lead in human resource development of engineering technicians for the state's industry. This lead ensures that the industries locating in Georgia, or existing industries planning expansion or retooling will have a readily available supply of highly skilled, educated, and technically adaptable technicians. Over two million Georgians have been trained in the past twenty years in the state's network of thirty technical schools, junior and community colleges.

A quantum step was taken in 1982 when the General Assembly appropriated over $13 million to upgrade the technical school programs to "state-of-the-art" in the electronics, electromechanical and mechanical technologies. In that allocation were directives to develop two year engineering technology programs in the same three fields. These two year programs for a degree of Associate of Applied Technology were begun in September, 1982. The new curriculum, highly qualified technical staff, the latest in instructional equipment and a highly motivated student body are now in place. Our first graduating classes enter the "World of Work" in June 1984. The rhetoric of what should be done is behind us; high technology training for engineering technicians is a fact in Georgia.

New and expanding industries will find a new atmosphere of cooperation where the human resources required to ensure a skilled technician workforce is available. Productive and credentialed employees are available with a positive attitude toward change, adaptability, flexibility and upward mobility.

Each of the three high technology programs is based upon a solid foundation of mathematics, physics and an understanding of the fundamentals basic to the technologies. An understanding of systems, close ties to local business and industry, computer literacy, and characteristics of the high technology programs.

The Georgia "High Technology Advisory Council" was appointed by the Governor as a blue ribbon committee to advise the executive branch of government, the General Assembly, the Board of Education, the Board of Regents and the new Board on Post Secondary Vocational Education regarding high technology and engineering technology education issues. The council is composed of 12 high technology industry representatives in the state and is coordinated by the High Technology Coordinator.

Georgia's commitment to industry, "hi-tech" and quality training is now in place. Contained herein are the coordinated pieces that make up a comprehensive and viable program in the engineering technologies. It is in the basics - this is and will be the difference in Georgia's human resource development product..........the engineering technician.

ELECTRONICS ENGINEERING TECHNOLOGY CURRICULUM

DEVELOPED BY

THE HIGH TECHNOLOGY CURRICULUM PROJECT

VOCATIONAL AND CAREER DEVELOPMENT DEPARTMENT

GEORGIA STATE UNIVERSITY

ATLANTA, GEORGIA

HARMON R. FOWLER, DEPARTMENT CHAIRMAN

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Education for The Technician: An Introduction

RATIONALE

Relevant education and training to prepare engineering technicians is a critical concern for the productivity needs of this nation. As new and changing technologies and processes for manufacturing, construction, communication, energy, and research and development occur with great rapidity, the need for engineering assistants who can perform the "nuts-and-bolts" problem-solving tasks associated with current technology has increased significantly. Modern industrial and engineering devices that are multisystem in nature require the sort of developmental, maintenance, support, and operational personnel who can change, adjust, and adapt to new situation and utilize increasingly sophisticated hardware with a minimum of retraining. In all, this trend toward innovation as the status-quo has heightened the need for a trained technician who combines theoretical and conceptual knowledge with the manipulative, "hands-on" skill of an artisan or craftsman. It is toward this end that modern technical education must be focused. The remainder of this document offers information and procedures necessary to train engineering technicians who can make a contribution in the emerging technologies.

PURPOSE AND OBJECTIVES

PURPOSE

The purpose of the Engineering Technology Program in Georgia is to produce specialists who possess the broad base of knowledge, skill, and attitude necessary to be productive in modern technical occupations that are characterized by rapid change and highly sophisticated content.

OBJECTIVES

1. To provide basic knowledge, skill, and attitude development based on a systematic analysis of the occupational domain to be served.
2. To produce a technician who is able to deal with the complex systems interactions that characterize modern technological environments.
3. To provide program options that allow in-depth study in specialized areas of the occupational domain beyond the basic skill level.
4. To provide for awarding of credit leading to an associate degree credential, as well as options toward other degree credentials.
5. To provide instruction that maximizes the application of knowledge, skills, and attitudes to real work situations.
6. To provide instruction that prepares the student for the complex problem-solving nature of highly technical occupations.
7. To fully coordinate the high-technology program with needs of business and industry through a process of school-community-business inter-cooperation.
8. To provide a system of instruction that is fully responsive to, and perceptive of, the intrinsic nature of change and innovation in highly technical occupations and disciplines.

TECHNICIANS DEFINED

In general the work role of the engineering technician falls between that of the vocational-industrial tradesman and that of the professional engineer. This is a broad range and is ill-defined in practice, having gray areas of work requirements at either end of the continuum and at many points in between. Perhaps the best way to define a technician is by a summary of tasks performed and the accompanying skills required. This must of necessity be done in a broad and generalized fashion with provisions for more specificity left to individial job descriptions. (The basis for this description may be found in a U.S. Office of Education research report entitled Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs.)

It is generally agreed that the engineering technician must have the following kinds of special skills and and abilities:

1. Proficiency in the use of the disciplined and objective scientific method in practical application of the basic principles, concepts, and laws of physics as they comprise the scientific base for the individual's field of technology.
2. Facility with mathematics; ability to use algebra and trignometry as problem-solving tools in the development and definition of, or to quantify, scientific phenomena or principles; and, when needed, an understanding of - though not necessarily facility in - higher mathematics through analytical geometry and some calculus according to requirements of technology.
3. A thorough understanding and facility in the use of materials, processes, apparatus, procedures, equipment, methods, and techniques commonly used in the technology.
4. An extensive knowledge of a field of specialization with an understanding of applications of the underlying physical sciences as they relate to the engineering or industrial processes, or research activities that distinguish the technology of the field. The degree of competency and depth of understanding should be sufficient to enable technicians to establish effective rapport with scientists, managers, and engineers with whom they work and to enable them to perform a variety of det

5. Communication skills that include the ability to record, analyze, interpret, and transmit facts and ideas with complete objectivity orally, graphically, and in writing.

Activities Performed

Technicians are expected to perform work tasks and/or support to engineers related to any of a combination of the following kinds of activities:

1. Applies knowledge of science and mathematics extensively in rendering direct technical assistance to physical scientists or engineers engaged in scientific research and experimentation.

2. Designs, develops, or plans modifications of new products, procedures, techniques, processes, or applications under supervision of scientific or engineering personnel in applied research, design, and development.

3. Plans, supervises, or assists in installation and inspection of complex scientific apparatus, equipment, and control systems.

4. Advises regarding operation, maintenance, and repair of complex apparatus and equipment with extensive control systems.

5. Plans production or operations as a member of the management unit responsible for efficient use of manpower, materials, money, and equipment or apparatus in mass production or routine technical service.

6. Advises, plans, and estimates costs as a field representative of a manufacturer or distributor of technical appartus, equipment, services, and/or products.

7. Assumes responsibility for performance of tests of mechanical, hydraulic, pneumatic, electrical, or electronic components or systems in the physical sciences and/or for determinations, tests and/or analyses of substances in the physical and other engineering-related sciences; and/or for determinations, tests and/or analyses of substances in the physical and other engineering-related sciences; and prepares appropriate technical reports covering the tests.

8. Prepares or interprets engineering drawings and sketches, or writes detailed scientific specifications or procedures for work related to physical sciences.

9. Selects, compiles, and uses technical information from references such as engineering standards, procedural outlines, and technical digests of research findings.

10. Analyzes and interprets information obtained from precision measuring and recording instruments and/or special procedures and techniques and makes evaluations upon which technical decisions are based.

11. Analyzes and diagnoses technical problems that involve independent decisions and and judgement that require, in addition to technical know-how, substantive experience in the occupational fields.

12. Deals with a variety of technical problems involving many factors and variables that require an understanding of applied scientific and technical understanding - the antithesis of narrow specialization.

It is recognized that no two-year technical training program will be sufficient to prepare engineering technicians for all the problems they will encounter in the workplace. The training should however be sufficient to:

1. Provide occupational skills that are compatible with at least entry-level employment in the chosen field.

2. Provide a broad base of knowledge in science, mathematics, and technical subjects that will allow the technician to progress to higher levels of job competence in an environment characterized by rapid change and innovation.

A DESCRIPTION OF ELECTRONIC ENGINEERING TECHNOLOGY

The purpose of this section is to describe what an Electronic Engineering Technician does and to give some feel for what the general occupational field of electronics is like.

HISTORY

In the 1920's, it was popular to build a radio receiver with a silver "cat's whisker" wire and a lead sulfide crystal (galena). The vacuum radio tube however, developed rapidly and replaced the "cat's whisker." In the 1950's scientists could see the limitations of vacuum tubes, particularly in computer and space application, because of their bulkiness and the heat they generated. The use of crystals instead of radio tubes was revived, and very rapidly developed.

A great deal of this progress was due to the space program. The demand for miniaturization in rockets led to the development of the integrated circuit. Due to this miniaturization, computers are now being built on a one-square-foot circuit board. Some are even being built on circuit boards with less area. Some of today's hand-held calculators perform more functions than early generation computers. Some of these earlier computers required the space of a large room. The associated wiring also required a large space. In some cases the floor might have to be raised or the ceilings lowered to provide this additional wiring space. Along with these space requirements, some of the earlier computers would require temperature and humidity-controlled environments. Today's computers will usually operate at room temperature with no problems. Because of this miniaturization, more and more computer circuits are being built on less and less area. This will bring about the use of higher-level language and performance of more and more functions.

Even though many advancements have been made in computers, this is not the only area of advancements in electronics. Due to miniaturization many advancements have been made in the electronic communication field. Today, radio receivers are being built on a single integrated circuit chip. Hearing aids are built into the tip of eyeglass frames, and as units that fit entirely in the ear. Microprocessors are used in industry to automatically compensate for undesirable variations in complex processes. This curriculum guide provides information on preparing technicians for the complex and exciting world of modern electronics.

THE ELECTRONIC ENGINEERING TECHNICIAN'S ROLE

Electronic Engineering Technicians are employed in many different types of jobs. An EET, Electronic Engineering Technician, may be employed in one of the following six broad job classifications:

1. Field Serivce Technician.
2. Broadcast Engineer.
3. Operations Technician.
4. Bench Technician.
5. Engineer's Assistant.
6. Sales Engineer.

There are many job titles. Some may be used by just one company. The job classifications listed above could also be job titles.

Field service and sales technicians are those who sell and service equipment in the user's place of business. This job classification usually requires a lot of travel. The required travel may be local, statewide, or nationwide. Field service technicians may service equipment such as computers, communication systems, or electronic control systems. They are capable of installing, operating, troubleshooting, and training at the customer's location. Communication abilities are important in this field.

Broadcast engineer is a term usually used for technicians in public broadcast communications. When you think of public broadcast communications, you usually think of standard AM and FM radio and television stations. This type of job could encompass electronic equipment servicing, and station operation. However, there are many other areas in which you might work. These include mobile communications gear (police and emergency vehicles), ground-based microwave systems, and statellite communications. It should be noted that anyone who works on a broadcast transmitter must have proper certification by the Federal Communications Commission.

An operations technician works in a manufacturing facility that maintains automated equipment. He or she checks and maintains electronic control devices and systems, checks and calibrates measuring equipment, and trains skilled plant workers in the operation of electronically controlled equipment. This technician may also fabricate special electronic apparatus for use in the manufacturing plant.

Bench technician could be a job title as well as a job description. However, it is usually a job description. This type of job usually does not require travel. A bench technician is a technician who services electronic equipment in simulated environment, such as radio and TV repairer.

An engineer's assistant or research assistant is usually a technician who works closely with an engineer. This technician might do a variety of jobs to assist the engineer in developing new devices or doing basic research. Some of these jobs might include building, testing, or troubleshooting circuit prototypes.

The above job classifications are not isolated to one area of electronics. An example of this could be the engineer's assistant. The engineer's assistant might build the prototype of a communications, computer, or industrial control circuit. Another example would be a sales engineer who might have technical knowledge of communications and therefore sell communications equipment. Another sales engineer might have technical knowledge of computers and sell computers or computer equipment.

There are many job titles for an Electronic Engineering Technician. The ones discussed here are general in description and could differ from a specific job title in a particular company. The following job description for electronics technician is re-printed from the Dictionary of Occupational Titles (DOT) of the U.S. Department of Labor.

003.161.014 ELECTRONICS TECHNICIAN (PROFESSIONAL AND KINDRED)

Applies electronic theory, principles of electrical circuits, electrical testing procedures, engineering mathematics, physics, and related knowledge to lay out, build, test, troubleshoot, repair, and modify developmental and production electronic equipment, such as computers, missile-control instrumentation, and machine tool numerical controls: Discusses layout and assembly problems with ELECTRONICS ENGINEER (professional and kindred) and draws sketches to clarify design details and functional criteria of electronic units. Assembles experimental circuitry (breadboard) or complete prototype model according to engineering instruction, technical manuals, and knowledge of electronic systems and components and their functions. Recommends changes in circuitry or installation specifications to simplify assembly and maintenance, Sets up standard test apparatus or contrives test equipment and circuitry, and conducts functions, operations, environmental, and life tests to evaluate performance and reliability of prototype or production model. Analyses and interprets test data. Adjusts, calibrates, aligns, and modifies circuitry and components and records effects on unit performance. Writes technical reports and develops charts, graphs, and schematics to describe and illustrate systems operating characteristics, malfunctions, deviations from design specifications, and functional limitations for consideration by professional engineering personnel in broader determinations affecting systems design and laboratory procedures. May operate bench lathes, drills, and other machine tools to fabricate nonprocurable items, such as coils, terminal boards, and chassis. May check out newly installed quipemnt in airplanes, ships, and structures to evaluate system performance under actual operating conditions. May instruct and supervise lower-grade technical personnel. May be designated according to specialization in electronic application as COMPUTER-LABORATORY TECHNICIAN (professional and kindred); DEVELOPMENT-INSTRUMENTATION TECHNICAN (professional and kindred); ELECTRONIC-COMMUNICATIONS TECHNICIAN (professional and kindred); ELECTRONIC TECHNICIAN, NUCLEAR REACTOR OPERATOR TRAINEE (professional and kindred); ENGINEERING-DEVELOPMENT TECHNICIAN (aircraft-aerospace manufacturing); SYSTEMS-TESTING-LABORATORY TECHNICIAN (professional and kindred).

CAREER OPPORTUNITIES IN ELECTRONICS

A wide diversity of employment opportunities are available to electronic graduates, so many that it would be impractical to try to list them all. Electronic equipment is so widely used that electronic technicians are needed in hundreds of different areas, a few of which are described below.

Computer repair might include field service, component level trouble-shooting, or programming equipment for testing purposes. Computers are used increasingly to program machines to perform manufacturing operations; thus manufacturing operations; thus many industries employ computer repair technicians.

Equipment testing involves operating computeried test equipment. Equipment testing might also involve writing computer programs to automatically test equipment as well as equipment maintenance and calibration.

Electronic Engineering Technicians can usually find jobs in the communications field as technicains. In this field a technician might be expected to provide maintenance for various types of equipment. Some of this equipment might be microcomputers, transmitters, cameras, video tape recorders, and satellite equipment.

Computer engineering is a job that includes working with engineers on the design and testing of computers. In computer engineering a technician might be involved in writing programs for testing as well as solving interface problems. The above classifications are a few general career opportunities in the field of electronics.

Nuclear instrumentation technicians work in nuclear-fueled power plants, research facilities, and nuclear fuel reprocessing plants, maintaining, operating, and troubleshooting instrumentation associated with nuclear reactor functions.

Electronic commponent or unit design (packaging) technicians aid in the design and construction of electronic components for various appliances and instruments. A stereo amplifier is a good example of a "packaged" unit. Other components might include the control system for a robot, instrumentation modules in a manufacturing plant, electronic air condirioning control units and video game components.

Product evaluation technicians evaluate products for potential purchase, sales, various applications, and in some cases, for information about competitive products. For example, an electronic motion sensor might be evaluated for possible applications in home burglar alarms, manufacturing robots, or automatic door-openers.

Quality-control technicians often work in plants where electronically-controlled equipment is used to test products at various points in production.

Biomedical electronics technicians work in research institutions and hospitals in various phases od equipment design, maintenance, and operation. Most equipment that monitors biological processes, such as cardiac monitors, spirometers (for measurement of respiratory function), is electronically controlled. Many breakthroughts have been made also in the design of electronic aids to handicapped persons, such as visual detectors for blind persons, or electronic sensors that actuate artificial limbs or muscles.

Rockets and space telemetering technician work with telemetry systems that are sent into outer space. Telemetry is the measurement of a physical quantity, such as voltage, pressure, or temperature, and transmission of that quantity to a receiving apparatus that displays or records it. Space telemetry made possible the pictures of Saturn brought to us by way of the Voyager spacecraft.

TABLE 1. PROJECTED JOB OPENINGS IN GEORGIA FOR HIGH-TECHNOLOGY INDUSTRY

YEARS	RANK	TECHNOLOGY	"Most likely"Average Annual Job Openings
1980-1985	1	Computer/Computer Services	4,872
	2	Communications	1,884
	3	Avionics	800
	4	Robotics/Automation	643
	5	Fiber/Laser Optics	170
	6	Biology	80
	7	Solar Energy	9
1985-1990	1	Computer/Computer Services	5,472
	2	Communications	3,475
	3	Avionics	1,074
	4	Robotics/Automation	848
	5	Fiber/Laser Optics	315
	6	Biology	160
	7	Solar Energy	20
1990-2000	1	Communications	7,220
	2	Computer/Computer Services	6,222
	3	Avionics	1,713
	4	Robotics/Automation	1,244
	5	Fiber/Laser Optics	800
	6	Biology	450
	7	Solar Energy	93

EET PROGRAM

The electronic engineering technology, EET, program is a seven-quarter program with opportunity for indepth study. This program is made up of courses common to the electromechanical engineering technology, EMT, and the mechanical engineering technology as well as EET core and elective courses.

There are several courses common to all three engineering technology programs which are:

Mathematics I, II, and III
Physics I, II, and III
DC Circuits
AC Circuits
Graphics - (Mechanical Drafting)
Technical Communications
Economics
Human Relations
Computer Fundamentals
Electromechanical Devices

The English, technical communications and human relations courses will enhance the student's ability to communicate through technical reports and interpretation of technical data. These are important in all fields, but none more than sales and service.

Courses in electromechanical devices and fundamentals of electricity and electronics will provide the student with an introduction to electricity as well as motors and generators. Today, the engineering technician, regardless of specialty area, needs to have a basic understanding of electricity and electromechanical devices. The electronics engineering technician must have a degree of understanding and competency to enable the individual to do such work as detail design using established design procedures.

Graphics is a mechanical drafting course that each engineering technology student must take unless transfer credit is given. This course will enhance the student's ability to understand engineering diagrams that are used in everything from bridges to printed circuit boards.

Economics is another required course that is important to each student. This course will aid the engineering technician in naking cost estimates on projects. Even more important, this course will prepare the student to function in today's economic environment.

Engineering technology principles can be obtained from courses in mathematics, physics, materials and processes, and computer programming. When faced with technical problems, these principles will help the engineering technician understand and solve these problems.

EQUIPMENT USED BY THE ELECTRONIC ENGINEERING TECHNICIAN

The amounts and types of test equipment available for use by the electronic engineering technician appears to be overwhelming when first viewed. However, upon closer examination you would find that all test equipment instruments seem to belong to one of three basic categories: meters, plotters, and generators.

METERS

Just as there are three basic categories of test equipment, there are two subcategories of meters. The designation of the type of meter is based upon the type of signals that are generated and modified between the input to the device and the output of the device. These two categories are called analog and digital.

Analog Meters

The analog meter is characteried by signals that are continuously variable, and thus the output data is displayed by a needly moving in front of a fixed scale (or vice versa in certain circumstances). The analog meter was the first type of electronic test equipment available for use by technicians and still forms a very large group of instruments.

Some of the typical analog meters that you will soon encounter go by the descriptive names of voltmeter, for measuring voltage; ammeter, for measuring electric current (amperes); ohmmeter, for measuring the electrical resistance (ohms) of components; Volt-Ohm-Multimeter (VOM), an instrument that can measure all the above and that has several ranges for each function.

Digital Meters

In contrast to the analog meter, the signals found in the conditioning circuitry of these meters are not continuously variable but are found in discrete amounts that can be represented by whole numbers. The digital meter is relatively new to the scene, but it is gaining in popularity because of the high degree of accuracy and resolution of measurements and the low production costs of the instruments.

The most common digital meter you will soon encounter is the DMM or Digital Multimeter. Where the typical accuracy of the analog multimeter was no better than +/- 3% of a full-scale reading, the modern DMM can be expected to have a basic accuracy better than +/- 0.5% of the reading.

Other Meters

Other meters available for use today offer accurate measure of many electronic quantities other than the basic parameters of voltage, current and resistance. Meters can also provide the measure of frequency, phase angle, impedance, reactance, capacitance, inductance, and power. Meters are the largest of the categories of test instruments and often can be found in conjunction with the other two categories.

PLOTTERS

The test equipment that fits under this category is identified by the fact that measurements are presented visually either on the face of a cathode-ray tube or on paper (graph). Another identifier is that this type of test equipment shows how one measured variable is related to another variable. This is unlike the meter equipment that can only show the instantaneous value of one variable at any one time.

The plotting equipment that displays data by a cathode-ray-tube (CRT) is best known as an oscilloscope. The oscilloscope can present the value of voltage with respect to time, where the vertical divisions are measured in volts per centimeter and the horiontal divisions are measured in seconds per centimeter. Another type of plotting equipment that uses the CRT to display data is called the spectrum analyer. With this instrument the horizontal display represents frequency and the vertical display represents voltage or signal level. Now, more exotic instruments that use the CRT for displaying data are entering the market under the general name "analyzer"; these instruments can display many different types of data.

Plotting equipment that displays data via paper are known as chart recorders (or X-Y plotters) and strip-chart recorders. These instruments can display the same type of data as the instruments mentioned above, but do so in the form of a permanent record. An advantage of these instruments is that they are available with multiple pens (each of which can write with a different color), which gives one instrument the ability to display many variables.

The plotting test equipment can be applied with great success to many measurements where its use can provide greater understanding than the use of meter devices.

GENERATORS

The last category of electronic test equipment to be examined is the generator. Generators allow the technician to select an input a signal for diagnostic work in troubleshooting faulty instruments or systems. There is no single type of generator since there is no single type or range of signal frequencies. Because electronic devices use many different types of signals there is a need for many different types of signal generators. In addition there are many ranges of frequencies, each requiring its own generator to simulate signals in. Some generators are designed to produce one signal at one frequency at any moment in time; other generators are designed to "sweep" or to change frequency with respect to time.

The generators available to the electronic engineering technician provide and invaluable aid in testing and analyzing components, circuits, and systems. Your introduction to generators will most likely start with one of two common unstruments, the function generator of the audio signal generator. Some of the other generators with which you will come into contact are known by the names oscillator, frequency synthesier, sweep oscillator, pulse generator, and so on. As an electronic engineering technician, the generators will be valuable tools in accomplishing assigned tasks.

INNOVATIONS AND TRENDS IN ELECTRONICS

In the past, and up until now, vacuum tubes have been used in electronics for large power applications. There are some bipolar junction transistors that have power handling capabilities of several hundred watts. However, this is not enough when some of the tasks performed by electronic devices require power-handling capabilities of several thousand and even hundreds of thousands watts. Therefore, vacuum tubes are still being used today. Electronic devices, such as the field-effect transistor, are being produced with more and more power-handling capabilities. It is suspected that these field-effect transistors will take over more and more jobs now being performed by the vacuum tubes.

Oscilloscopes, pieces of test equipment used frequently by electronic technicians, have been using vacuum tubes to display test results, called waveforms. In the future, it is suspected that solid-state devices will replace these vacuum tubes in oscilloscopes.

Electronic test equipment has become more and more complex and more compact. Some test equipment will even check itself for faults. It is suspected that electronic test equipment in the future will test itself for faults and tell the technician what to do to repair it. This feature will probably be incorporated into the electronic equipment.

CURRICULUM MODEL

ELECTRONICS ENGINEERING TECHNOLOGY
STANDARD CURRICULUM - QUARTER SYSTEM
(SUGGESTED SEQUENCE)

	Class	Lab	Contact Hour	Cr
First Quarter				
D.C. Circuits	4	3	7	5
Computer Fundamentals	3	6	9	5
Algebra	5	0	5	5
Engineering Graphics	1	6	7	3
	13	15	28	18
Second Quarter				
Physics I	4	3	7	5
Trigonometry	5	0	5	5
A.C. Circuits	4	3	7	5
English & Composition	5	0	7	5
	18	6	26	20
Third Quarter				
Electronic Devices	4	3	7	5
Physics II	4	3	9	5
Analytic Geometry and Calculus	5	0	5	5
Circuit Analysis	4	3	7	5
	17	9	28	20
Fourth Quarter				
Semiconductor Analysis	3	3	6	4
Digital Electronics	3	3	6	4
Physics II	4	3	9	5
Elective Group I	4	3	7	5
	14	12	29	18
Fifth Quarter				
Electromechanical Devices	4	3	7	5
Linear Integrated Circuits	4	3	7	5
Elective Group II	4	3	7	5
Digital Applicaitons	4	3	7	5
	16	12	28	20
Sixth Quarter				
Control System Components	4	3	7	5
Technical Communications	5	0	5	5
Elective Group III	4	3	7	5
Elective Group III	4	3	7	5
	17	9	26	20
Seventh Quarter				
Industrial Relations	5	0	5	5
Principles of Economics	5	0	5	5
Elective Group IV	4	3	7	5
ELT Problems (Elective)	0	9	9	3
	14	12	26	18

ELECTRONICS ELECTIVES

Group I - (Fourth Quarter)
Communication Circuits
(Industrial Electronics may elect courses from Electromechanial or Mechanical sequence e.g. Mechanical Devices & Systems, Fluid Power, CAD I)

Group II - (Fifth Quarter)
Communications Circuits
Communication Systems
EMT or MET courses

Group III - (Sixth Quarter)
Micro-computer Applications I
Digital Communications
Satellite & Telecommunications
EMT or MET courses

Group IV - (Seventh Quarter)
Antennas Transmission lines and Microwaves
Micro-computer Applications II
Digital Communications
EMT or MET courses
ELT Problems

It is recommended that EET students have the following courses as a minimum.

Communications & Social Studies	20 hrs.
Mathematics & Science	30 hrs.
Computer & Graphics	8 hrs.
Technical Core	
D.C. Circuits	5 hrs.
A.C. Circuits	5 hrs.
Circuit Analysis	5 hrs.
Electronic Devices	5 hrs.
Semiconductor Analysis	5 hrs.
Digital Electronics	5 hrs.
Electromechanical Devices	5 hrs.
Communication Circuits	5 hrs.
Digital Applications	5 hrs.
Control Systems Components	5 hrs.
Micro-computer Applications I	5 hrs.
	54 hrs.
Electives	20 hrs.
	132 hrs.

RELATED COURSES

COMPUTER FUNDAMENTALS

COURSE DESCRIPTION

This course will provide students with knowledge, skills, and attitudes to use the microcomputer as a tool to solve engineering technology problems typically encountered throughout their programs. Topics taught will include microcomputer architecture, programming concepts, branching, looping, arrays, functions, subroutines, data files, graphics and applications.

PREREQUISITE: Admission to the Program

CREDIT HOURS: 3-6-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introduction to the Microprocessor A. Hardware B. Terminolgy C. Execution modes D. Programs	3	6
II. Introduction to Concepts of Programming A. Flowcharting B. Variable types C. Operations and formulas D. Simple BASIC programming E. Program comments F. Storage and retrieval of programs	3	6
III. Branching and Looping A. Relational operations B. Logical operations C. Conditional branching D. Multiple branching E. The stop statement F. Loops G. Nested loops	3	6
IV. Arrays A. Lists and tables B. Subscripted variables C. Defining arrays	3	6
V. Functions and Subroutines A. Library functions B. User functions C. Defining	3	6

	Student Contact Hours	
	Class	Laboratory
D. Random numbers		
E. Defining subroutines		
F. Referencing subroutines		
VI. Data Files	3	6
A. Creating sequential data files		
B. Using sequential data files		
VII. Engineering Applications	3	12
A. Electronic technology problems		
B. Electromechanical technology problems		
C. Mechanical technology problems		
VIII. Graphics	3	6
A. Drawing bar charts		
B. Graphing functions		
C. Computer-generated imagery		

STUDENT LABORATORIES

- Execute instructor-supplied simple programs.
- Develop, debug, and execute a simple BASIC program.
- Save, retrieve, and execute a previously developed BASIC program.
- Create a data file, develop a program that will manipulate the file, and produce an acceptable output.
- Given a typical engineering program including all necessary equations and data, develop programs that will solve the problems and produce acceptable output.
- Develop, debug, and execute a program which will produce the answers in tabular form.
- Develop, debug, and execute an interactive program.

STUDENT COMPETENCIES

Upon completion of this course the student will be able to:
- Identify microcomputer hardware and define the associated terms.
- Execute pre-written programs.
- Write, save, retrieve, and execute simple programs in BASIC.
- Write BASIC programs using branching and looping statements
- Write BASIC programs manipulating data using arrays.
- Write BASIC programs using library functions.
- Develop functions and subroutines and incorporate them into BASIC programs.

- Write programs that use and manipulate data files.
- Solve selected technology problems using the microcomputer.
- Define and identfy microcomputer hardware (microcomputer, keyboard, CRT, disk drive, cassette, printer, floppy disk).
- List execution modes (execution, command or immediate, systems, edit). (These may differ according to manufacturer.)
- Execute a BASIC program which has been stored on a disk.
- Enter via keyboard and execute a program which has been supplied by the instructor.
- Discriminate between keywords and control words.
- Construct a flowchart which will display the logic of a given program or problem.
- Determine whether or not a line number is necessary in a given expression.
- Construct BASIC statements to compute given formulas.
- Write a simple BASIC program.
- List and give examples of variable types (numeric, string, constant).
- Identify symbols used for arithmetic operations (Addition, subtraction, multiplication, division, and exponentation).
- Outline correct structure for BASIC programs (identification, purpose, process).
- SAVE a BASIC program on tape or floppy disk.
- Retrieve a program which has been stored.
- Write BASIC statements using relational operators (less than,greater than, less than or equal to, greater than or equal to, less than or greater than, equal to).
- Write BASIC statements using logical operator (AND, OR NOT).
- Write BASIC programs using IF-THEN-ELSE statements.
- Demonstrate use of STOP statement to halt program and check progress.
- Identify and code algorithms involving nested loops.
- Generate lists and tables using subscripted variables.
- List examples of subscripted string and numeric variables.
- Define an array using the DIM statement.
- List keywords used as library functions (trig functions ABS, INT, RND, AQR).
- Code a DEF FN statement.
- Code algorithms using GOSUB.
- Code statements using the TAB(N) function.
- Code algorithms which will accumulate.
- Build a data file which contains at least five records.
- Access data files which have been previously created.
- Write, debug, and execute at least one program which solves a problem in the student's major area of interest.
- Plot a given point on the CRT.

RECOMMENDED TEXTS

Bent, Robert J. and Sethares, George C. Basic: An Introduction to Computer Programming. 2nd ed. Monterey, CA: Brooks/ Cole Publishing Co., 1982.

Shelly, Gary and Cashman, Thomas, Introduction to BASIC Programming. Anaheim, CA: Anaheim Publishing Co., 1982.

ECONOMICS

COURSE DESCRIPTION

Basic principles of the American economic system of free enterprise will be covered. An emphasis will be placed not only upon the classic economic principles, but upon understanding these principles as they apply to current economic trends. The role of technical/technologically-oriented industries in the economics of today to be emphasized.

PREREQUISITE: None

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours Class	 Laboratory
I. Introduction (Basic Economic Concepts)	1	
II. Economic Forces and Indicators	2	
A. Economics defined		
B. Modern specialization		
C. Increasing production and consumption		
D. Measures of economic activity		
1. gross national product		
2. national income		
3. disposable personal income		
4. industrial production		
5. employment and unemployment		
III. Capital and Labor	3	
A. Tools (Capital)		
1. the importance of saving and investment		
2. the necessity for markets		
B. Large-scale enterprise		
C. Labor		
1. population characteristics		
2. vocational choice		
3. general education		
4. special training		
5. management's role in maintaining labor supply		
IV. Business Enterprise	7	
A. Forms of business enterprise		
1. individual proprietorship		
2. partnership		
3. corporation		
B. Types of corporate securities		

Student Contact Hours
Class Laboratory

1. common stocks
2. preferred stocks
3. bonds

C. Mechanics of financing business

D. Plant organization and management

V. Factors of Industrial Production Cost 10

A. Buildings and equipment
1. initial cost and financing
2. repair and maintenance costs
3. depreciation and obsolescence costs

B. Materials
1. initial cost and inventory value
2. handling and storage costs

C. Processing and production
1. methods of cost analysis
2. cost of labor
3. cost of supervision and process control
4. effect of losses in percentage of original product compared to finished product (yield)

D. Packaging and shipping

E. Overhead costs

I. Profitability and business survival

VI. Price, Competition and Monopoly 5

A. Function of prices

B. Price determination
1. competitive cost of product
3. supply
4. interactions between supply and demand

C. Competition, benefits and consequences
1. monopoly and oligopoly
2. forces that modify and reduce competition
3. history of government regulation of competition

D. How competitive is our economy?

	Student Contact Hours Class	 Laboratory
VII. Distribution of Income	2	
A. Increasing real income		
B. Marginal productivity		
C. Supply in relation to demand		
D. Incomes resulting from production		
1. wages		
2. interest		
3. rents		
4. profits		
E. Income distribution today		
VIII. Personal Income Management	2	
A. Consumption - the core of economics		
B. Economizing defined		
C. Personal and family budgeting		
D. Analytical buying		
1. applying quality standards		
2. consumer's research and similar aids		
E. The use of credit		
F. Housing - own or rent?		
IX. Insurance, Personal Investments and Social Security	3	
A. Insurance defined		
B. Life insurance		
1. group, industrial, ordinary		
2. type of policies - advantages and disadvantages		
C. Casualty insurance		
D. Investments		
1. savings accounts and government bonds		
2. corporation bonds		
3. corporation stocks		
4. annuities		
5. pension plans		
E. Social Security		
1. old-age survivor's insurance		
2. unemployment compensation		
3. medicare		
X. Money and Banking	3	
A. Function of money		
B. The nation's money supply		

	Student Contact Hours Class	 Laboratory
C. Organization and operation of a bank		
1. sources of deposits		
2. the reserve ratio		
3. expansion of bank deposits		
4. sources of reserves		
D. The Federal Reserve System		
1. service functions		
2. control of money supply		
E. F.D.I.C.		
XI. Government Expenditures, Federal and Local	3	
A. Economic effect		
B. Functions of government		
C. Analysis of government spending		
D. Future outlook		
E. Financing government spending		
1. criteria of sound taxation		
2. tax revenues in the U.S.		
3. the federal and state personal income taxes		
4. the coporate income tax		
5. the property tax		
6. commodity taxes		
XII. Fluctuations in Production, Employment and Income	5	
A. Changes in aggregate spending		
B. Output and employment		
C. Other factors affecting economic fluctuations		
1. cost-price relationships		
2. demand for durable goods		
3. supply of commodities		
4. effects of war		
5. inflation and deflation		
6. technology and automation		
D. Government Debt		
1. purposes of government		
2. how burdensome is the debt		
3. problems of debt management		
XIII. The United States Economy in Perspective	4	
A. Recent economic changes		
1. inflation and recession		
2. effects of trade imbalance		

	Student Contact Hours	
	Class	Laboratory
3. new products and industries		
4. increase in governmental controls		
B. Present economic problems of U.S. economy		
1. the world market		
2. international cooperation		
3. maintenance of prosperity and progress		
4. economic freedom and security		
C. Communism: nature and control by Soviet State		
D. Problems common to all systems		
E. Special economic problems of the U.S.		

STUDENT COMPETENCIES:

At the conclusion of this course, the student will be able to:

- Define what is meant by economics in the traditional sense and state the importance of economics to today's business enterprises.
- Explain the relationship of productivity, balance of trade, and gross national product.
- Explain the roles of capital and labor in the American economic system.
- Contrast individual proprietorships, partnerships, and corporations as methods of business orgranizations.
- Explain how businesses are financed.
- Define and/or explain the importance of the following terms to production cost: capital outlay, materials, direct labor, indirect labor, scrappage and efficiency, materials shipping and handling, overhead, taxation and government regulation.
- Explain how free enterprise is different from monopolistic or socialistic economies.
- Define real income.
- Compute real income given gross income and relevant variables.
- Plan a personal budget.
- Plan a projected program of personal investment, savings, and insurance.
- Explain the meaning of money in economic terms.
- Discuss orally or in writing the effects of government regulation on business and economics.
- List and briefly describe three major problems which affect the American economy today.

RECOMMENDED TEXTS

Amacher. Principles of Economics. (Second Edition). Southwestern Publishing, 1983.

Heilbraner and Thuran. The Economic Problem. Prentice-Hall, 1981.

Olsen and Kennedy. Economics: Principles and Applications (Nineth Edition). Southwestern Publishing, 1978.

Theussen, et al. Engineering Economy. (5th Edition). Prentice-Hall, 1977.

ENGLISH AND COMPOSITION

COURSE DESCRIPTION

This course is designed to enhance the student's skill in writing, grammar usage and composition. Topics for student exercises may be chosen from material discussed or experienced in technical courses. Course material will serve to integrate basic communication skills with studies in technical subject areas. Topics to be covered include grammar, writing skills and composition.

PREREQUISITE: Admission to Program

CREDIT HOURS: 5-0-5

COURSE OUTLINE

	Student Contact Hours Class	Student Contact Hours Laboratory
I. Communications and the Technician	5	
A. Why the technician must be proficient		
B. Importance of written communications as an essential skill		
C. Study skills		
1. notetaking skills		
2. following written and oral instructions		
3. test-taking skills		
II. Composition (Emphasis on Student Writing)	47	
A. Diction		
B. Sentence Review		
1. review of basic parts of speech		
2. complete sentences		
3. use and placement of modifiers, phrases, clauses		
4. sentence conciseness		
5. exercises in sentence structure		
C. Grammar usage		
1. capitalization		
2. punctuation		
3. subject-verb agreement		
D. Paragraph construction		
1. topic sentence		
2. development		

   3. unity and coherence
   4. transistional devices

E. Narration, description, and exposition

F. Theme construction
   1. thesis statement
   2. transitions
   3. conclusions

STUDENT COMPETENCIES

At the conclusion of the course, the student will be able to:

- Explain the need for effective written communication and an appreciation for the writing process.
- Use effective techniques for taking notes, following instructions, and taking tests.
- Analyze the ideas in essays related to technology and society.
- Recognize and articulate multiple points of view.
- Use commonly misused words correctly in basic sentences.
- Punctuate, capitalize, and spell correctly.
- Recognize and write simple, complex, compound, and complex-compound sentence structures.
- Rewrite ambiguous, wordy statements into clear, terse sentences.
- Recognize and write paragraphs using varied organizational techniques (cause and effect, description, definition, and so on).
- Write paragraphs containing well-defined topic sentences and develop each paragraph into a unified whole.
- Use transitional words and paragraphs to achieve coherence and unity in writing.
- Organize thoughts during the pre-writing stage using a written outline.
- Effectively write a unified, well-developed five paragraph theme following standard English grammer usage.

RECOMMENDED TEXTS

Hodges, John C., Whiten, Mary E., Harbrace College Handbook, 9th ed., New York, Harcourt, Brace, Jovanovich, 1982.

Lynch, Robert E. and Thomas, B. Swanzey, eds. The Example of Science: An Anthology for College Composition, Englewood Cliffs, NJ: Prentice-Hall, 1981.

Watkins, Floyd C. and Martin, Edwin T., Practical English Handbook, Boston, Houghton Mifflin.

INDUSTRIAL RELATIONS

COURSE DESCRIPTION

This course includes the study of the basis of human realtions and the organization of individual and group behavior. Leadership, organizational and social environments (including labor unions), career development, communications and group processes as well as selected operating activities are covered. Appropriate case problems are reviewed and discussed. Special emphasis is placed on typical industrial and business relationships in everyday situations.

PREREQUISITE: None

CO-REQUISITE: None

CREDIT HOURS: 5-0-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Fundamentals of Organizational Behavior	4	
A. Working with people		
B. Mainsprings of motivation		
C. Social systems		
D. Morale information and its use		
E. Developing a sound behavioral climate		
II. Leadership and Its Development	6	
A. The leadership role		
B. Effective supervision		
C. Development of participation		
D. Human relations training		
III. Organizational Environment	6	
A. Organizational structures		
B. Organizational dynamics		
C. The individual in the organization		
D. Informal organization		
IV. Career Development in Organizations	6	
A. Understanding career motivation		
B. Making career choices		
C. Attitudes and advancement		
D. Career development and management practices		

	Student Contact Hours Class	Laboratory
V. Social Environment A. Labor unions B. Working with unions C. Employment discrimination D. Managing scientific and professional employees E. Managing employees in international operations	4	
VI. Communications and Group Processes A. Communication with employees B. Communication groups C. Counseling and interviewing D. Group dynamics E. Managing change	10	
VII. Operating Activities A. Appraising and rewarding performance B. Using economic incentive systems C. Integrating work systems with people D. Understanding automation E. Organizational behavior in perspective	4	
VIII. Case Problems in Technical Organizations	10	

STUDENT COMPETENCIES

At the conclusion of the course, the student will be able to:

- List and describe 5 fundamental componenets of a sound organizational environment.
- Explain the critical role of leadership in developing an organizational climate.
- Describe the characteristics of an effective leader.
- List 4 basic types of organizational structures.
- Diagram an organizational structure and label components.
- Develop a personal career objective and explain the rationale for the choice.
- Discuss and evaluate the impact of unionization on the U.S. economy.
- Explain the importance of interpersonal communication in an organization.
- List and describe the various types of communication that are important at work.

- . Explain the possible impact of automation on the people in an organization.
- . Effectively formulate solutions to organizational problems presented by the instructor.

RECOMMENDED TEXTS

Yodar and Standohar, _Personnel Management and Industrial Relations_, Englewood Cliffs, NJ, Prentice-Hall, 1982.

Armine et al., _Manufacturing Organization and Management_, Englewood Cliffs, NJ, Prentice-Hall, 1982.

Everand and Shilt, _Business Principles and Management_, Southwestern Publishing, 1979.

TECHNICAL COMMUNICATIONS

Technical Communications will provide the student with working knowledge of the use of communication techniques, procedures, and formats used in industry and business. The student will learn accepted methods of describing devices and processes, and of making oral and written technical presentations. Also, proper use of written manuals, guides, specifications, and vendor instructions will be reviewed.

PREREQUISITE: English and Composition

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours Class	 Laboratory
I. Introducing Technical Communications	3	
A. Purpose of course		
B. Definition of technical writing		
C. Basic principles of technical writing		
D. Style		
1. audience		
2. purpose		
3. scientific attitude		
E. Introduction to oral communication		
II. Conducting Research	6	
A. Completing preliminary steps		
B. Assembling sources		
1. searching subject heading indexes		
2. using the card catalog		
3. consulting specialized guides		
4. locating bibliographies		
5. using indexes and abstract services		
6. using reference materials		
C. Using research results		
1. taking notes		
2. assembling an annotated bibliography		
III. Planning the report	5	
A. Outlines		
1. outlining effectively		
2. rules for formal outlines		
B. Abstracts and introductory summaries		

  - 1. types of abstracts
  - 2. suggestions for writing abstracts

- IV. Writing Definitions
  - A. What should be defined
    - 1. familiar words for unfamiliar things
    - 2. unfamiliar words for familiar things
  - B. How definitions are constructed
    - 1. informal
    - 2. formal
      - a. class
      - b. distinguishing characteristics
      - c. summary of formal usage
      - d. additional suggestions for formal usage
    - 3. amplified definitions
  - C. Where definitions should be placed

- V. Describe Mechanisms
  - A. Describing mechanisms
  - B. Components of the description of a mechanism
    - 1. some potential problems
    - 2. specifications
  - C. Describing malfunctions of a mechanism

- VI. Describing Processes
  - A. Describing a process
  - B. Problems encountered in describing a process
  - C. Instructions in a process
  - D. Describing malfunctions of a process

- VII. Putting Skills into Practice: Writing a Formal Technical Report
  - A. Writing the rough draft
    - 1. prefactory pages
    - 2. body of the report
    - 3. appendix
  - B. Editing the rough draft
  - C. Producing the final copy

- VIII. Presenting an Oral Technical Report

- A. Oral and visual aspects of technical communications
- B. Oral presentations and activities
  1. oral reports and presentations
  2. leading conferences and group discussions
- C. Visual illustrations
  1. what illustrations can do
  2. types of illustrations
- D. Presenting the oral report

STUDENT COMPETENCIES

- Explain the importance of technical communications to the engineering technician.
- Use appropriate reference materials in preparing a technical report.
- Write a formal and an informal outline for a technical report.
- Write an abstract for a technical report.
- Write appropriate definitions of technical terminology.
- Precisely describe the characteristics and components of mechanisms.
- Precisely describe the characteristics and componenets of processes.
- Prepare a formal technical report using accepted formats and style.
- Deliver orally an informative persuasive technical presentations using supportive visual aids.

RECOMMENDED TEXTS

Brenner, Ingrid, Mathes, J. C. and Stevenson, Dwight. The Technician As Writer. Indianapolis: Bobbs Merrill, 1980.

Messer, Ronald. Style in Technical Writing. Glenview, Il: Scott-Foresman, 1982.

Sherman, Theodore and Johnson, Simon. Modern Technical Writing. 4th edition. Englewood Cliffs, NJ: Prentice Hall, 1983.

MATHEMATICS AND SCIENCE COURSES

ALGEBRA

COURSE DESCRIPTION

This course is designed to develop and update algebraic skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic, and optical technologies. Topics to be covered include functions and graphs, linear equations, determinants, factoring, quadratics, and the solution of right triangles.

PREREQUISITES: Admission to Program

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Fundamental Concepts and Operations	13	
A. Numbers and literal symbols		
B. Fundamental laws of algebra		
C. The laws of exponents		
D. Scientific notation		
E. Exponents and radicals		
F. Addition and subtraction of algebraic expressions		
G. Multiplication and division of algebraic expressions		
H. Equations and formulas		
II. Functions and Graphs	6	
A. Functions		
B. Cartesian coordinates		
C. Graphing functions		
D. Solving equations graphically		
III. Linear Equations and Determinants	11	
A. Linear equations		
B. Graphical solution of systems of two linear equations in two unknowns		
C. Algebraic solution of systems		
D. Solution by determinants of systems of two linear equations in two unknowns		
E. Algebraic solutions of three linear equations in three unknowns		

	Student Contact Hours Class	 Laboratory
F. Solution by determinants of systems of three linear equations in three unknowns		
IV. Factoring and Fractions	10	
A. Special products		
B. Factoring		
C. Simplifying fractions		
D. Multiplication and division of fractions		
F. Addition and subtraction of fractions		
V. Quadratic Equations	5	
A. Quadratic equations. Solution by factoring		
B. Completing the square		
C. The quadratic formula		
VI. Variation (optional)		
A. Direct		
B. Inverse		
C. Joint		

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Write concepts mathematically using numbers and symbols.
- Perform mathematical operations using the fundamental laws of algebra and the laws of exponents and radicals.
- Make mathematical computations using scientific notation.
- Perform algebraic operations of addition, subtraction, multiplication, and division on algebraic expressions.
- Perform basic mathematical operations on equations and formulas to solve for any given variable.
- Graph relations and functions with two variables.
- Graphically solve two linear equations with two unknowns.
- Algebraically solve two linear equations with two unknowns.
- Use determinants to solve three linear equations in three unknowns.
- Identify the general form of first, second, and third degree equation products in three unknowns.
- Factor into prime factors algebraic expressions containing common monomial factors.
- Factor the difference of two squares.
- Factor trinomial expressions.
- Factor perfect square trinomials.
- Change a given algebraic fraction into a specified equivalent fraction.

- Perform operations of addition, subtraction, multiplication and division on algebraic fractions.
- Solve equations containing algebraic fractions.
- Solve quadratic equations by factoring.
- Solve quadratic equations by completing the square.
- Solve quadratic equations by use of the quadratic formula.
- Define trigonometric functions using the standard triangle.
- Solve right triangles.

RECOMMENDED TEXTS

Clar and Hart. Mathematics for the Technologies. Englewood Cliff, N.J.: Pretice-Hall, Inc.

Paul and Shaevel. Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ.: Prentice-Hall, Inc.

Washington, Allyn J. Basic Technical Mathematics with Calculus. 3rd Edition. Benjamin Cummings.

TRIGONOMETRY

COURSE DESCRIPTION

This course is designed to develop trigonometric skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic and optical technologies. Topics to be covered include trigonometric functions of angles, vectors, solutions to oblique triangles, graphs of trigonometric functions, j-Operator, identities, inverse functions and logarithms, exponents and radicals and additional solutions to systems and equations.

PREREQUISITE: Algebra

CO-REQUISITE: NONE

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Trigonometric functions of any angle	4	
A. Signs of the trigonometric function		
B. Radian		
C. Applications of the use of radian measure		
II. Vectors and triangles	7	
A. Vectors		
B. Application of vectors		
C. Oblique triangles		
D. The law of sines		
E. The law of cosines		
III. Graphs of the Trigonometric Functions		
A. Graphs of $Y=A \sin x$ and $Y=A \cos x$		
B. Graphs of $Y=A \sin bx$ and $Y=A \cos bx$		
C. Graphs of $Y=A \sin (bx+c)$ and $Y=\csc x$		
D. Graphs of $Y=\tan x$, $Y= \cot x$, $Y=\sec x$, $Y=\csc x$		
E. Application of the trigonometric graphs		
F. Composite trigonometric curves		
IV. Exponents and Radicals	7	
A. Positive integers as exponents		

	Student Contact Hours	
	Class	Laboratory
B. Zero and negative integers as exponents		
C. Fractional exponents		
D. Simplest radical form		
E. Addition and subtraction of radicals		
F. Multiplication and division of radicals		
V. The j-Operator	9	
A. Imaginary and complex numbers		
B. Operations with complex numbers		
C. Graphical representation of complex numbers		
D. Polar form of a complex number		
E. Exponential form of a complex number		
F. Products, quotients, powers and roots of complex numbers		
IV. Properties of Trigonometric Functions	4	
A. Fundamental trigonometric identities		
B. Sine and cosine of the sum and difference of two angles		
C. Double-angle formulas		
D. Half-angle formulas		
E. Trigonometric equations		
VII. The Inverse of Trigonometric Functions	2	
A. Inverse trigonometric functions		
B. Principal values		
VIII. Logarithms	5	
A. Exponential and logarithmic functions		
B. Graphs of $Y = b^x$ and $Y = \log_b x$		
C. Properties of logarithms		
D. Logarithms to the base 10		
E. Logarithms to the base e		
F. Solutions of the exponential and logarithmic equations		
IX. Additional Solutions to Equations and Systems of Equations	6	
A. Graphical solution of systems of equations		

B. Algebraic solution of systems of equations
C. Equations in the quadratic form
D. Equations with radicals

STUDENT COMPENTENCIES

At the conclusion if this course, the student will be able to:

- Define the six trigonometric functions.
- Determine the sign of the function of an angle.
- Find the value of a given function of an angle.
- Find the value of the angle of the inverse trigonometric function.
- Convert between systems of angular measurement.
- Make trigonometric computations with angles measured in radians.
- Define vector quanities and give examples.
- Graphically represent a vector.
- Graphically add and subtract vectors.
- Use vectors to solve problems by resolving vectors into rectangular components.
- Solve oblique triangles using the laws of sines.
- Solve oblique triangles using the law of cosines.
- Graph the trigonometric functions $Y = A \sin x$ and $Y = A \cos x$.
- Graph the trigonometric functions $Y = \sin (bx + c)$ and $Y = A \cos (bx + C)$.
- Graph the trigonmetric functions $Y = A \sin bx$ and $Y = A \cos bx$.
- Determine amplitude, period, and phase of periodic (sinusoidal) motion.
- Graph the trigonometric functions $Y = \tan x$, $Y = \cot x$, $Y = \sec x$, $Y = \csc x$.
- Describe various types of motion in terms of the sine curve.
- Graphically combine two or more trigonometric curves.
- Perform operations involving algebraic expressions containing fractional components.
- Reduce radicals to simplest form.
- Perform operations wtih algebraic expressions containing fractional components.
- Define and describe the complex number system.
- Perform complex numbers graphically.
- Represent complex numbers graphically.
- Write complex numbers in polar form.
- Write complex numbers in exponential form.
- Calculate the product, quotient, powers, and roots of complex numbers.
- Recognize and verify the basic trigonometric identities.
- Prove the vailidity of trigonometric equations by means of the trigonometric identities.

- Compute the sine and cosine of the sum and difference of two angles.
- Compute the value of the sine and cosine of the double angle.
- Compute the value of the sine and cosine of the half angle.
- Recognize and define inverse trigonometric functions.
- Compute the principal value of a given trigonometric function.
- Recognize and define an equation in exponential form.
- Recognize and define an equation in logarithmic form.
- Graph exponential and logarithmic functions.
- Perform algebraic operations with logarithmic expressions using the properties of a logarithm.
- Write a number as a logarithm to the Base 10.
- Write a number as a logarithm to the Base e.
- Solve exponenetial and logarithmic equations.
- Graphically solve systems of first and second degree equations with two variables.

RECOMMENDED TEXTS

Clar and Hart, Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel, Essentials of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall.

ANALYTIC GEOMETRY AND CALCULUS

COURSE DESCRIPTION

This course is a survey course designed to develop analytic geometry and calculus skills required for engineering technicians as applied to the solution of practical problems encountered in electrical, mechanical, thermal, hydraulic, pneumatic, and optical technologies. Topics to be covered include analytic geometry, derivatives, integrals, differentiation and integration of polynomial functions and transcendental functions and integration techniques.

PREREQUISITES: Algebra, Trigonometry

CREDIT HOURS: 5-0-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Elements of Analytic Geometry	8	
A. The straight line		
B. The circle		
C. The parabola		
D. The ellipse		
E. The hyperbola		
II. Sequences and Series (optional)		2
A. Finite sequences and series		
B. Infinite sequences and series		
C. Limit of a sequence or series		
III. Derivatives and Applications	15	
A. Limits		
B. The slope of a tangent to a curve		
C. The derivative		
D. Derivatives of polynomials		
E. Derivatives of products and quotients of functions		
F. The derivative of a power of a function		
G. The derivative as a rate of change		
H. Maximum and minimum problems		
I. Implicit differentiation		
IV. Integration and Applications	15	
A. Differentials and inverse differentiation		
B. The indefinite integral		
C. The area under a curve		
D. The definite integral		

Student Contact Hours
Class Laboratory

- E. Finding area by integration
- F. Volume by integration
- G. Applications for the integral
- H. Trapeziodal rule or rectangula method for approximating areas (optional)

V. Differentiation of transcendental functions 8

- A. Derivatives of the sine and cosine functions
- B. Derivatives of the other trigonometric functions
- C. Derivatives of the inverse trigonometric functions
- D. Derivatives of the exponential and logarithmic functions

VI. Integration Techniques (Optional) 4

- A. The genral power formula
- B. The logarithmic and exponential form
- C. Basic trigonometric forms
- D. Integration by parts
- E. Integration by substitution
- F. Use of the tables.

STUDENT COMPENTENCIES

At the conclusion of this course, the student will be able to:

- Find the straight-line distance between two points on a graph.
- Define and find the slope of a line.
- Write the equation of a straight-line given various properties of the line such as points on the line, slope and/or intercepts.
- Define a circle and write the equation of a circle with the center at (0,0) and with the center at any coordinate (x,y).
- Define and derive the equation of a parabola given appropriate data.
- Define and derive the equation of an ellipse given the appropriate data.
- Define and derive the equation of a hyperbola given the appropriate data.
- Find the sum of a finite arithmetic or geometric series and of other finite series.
- Find the nth term of a sequence.
- Find the sum of an infinite geometric series if one exists.
- Identify convergent and divergent sequences and series.

- Find the limit of an infinite sequence or series if it exists.
- Find the limit of an infinite sequence or series if it exists.
- Determine if a function is continuous.
- Determine the limits of a function if they exist.
- Find the slope of the tangent to a curve.
- Define and find the derivative of a function.
- Derive the derivatives of products and quotients of functions.
- Derive the derivative of a power of a function.
- Use differential calculus to solve problems involving rate of change.
- Use differential calculus to solve maximum and minimum problems.
- Use implicit differentiation to solve applied problems.
- Find the differential of a function.
- Find the antiderivative of a function.
- Define and find the indefinite integral of a function.
- Find the area under a curve.
- Define the definite integral of f (n).
- Find volume by integration.
- Apply integral calculus to solve problems involving moments of inertia, work, average values, etc.
- Compute derivatives of the sine and cosine functions.
- Compute derivatives of the other trigonometric functions.
- Compute derivatives of the inverse trigonometric functions.
- Compute derivatives of the exponential logarithmic functions.
- Integrate functions by use of the general power formula.
- Integrate functions in logarithmic and exponential form.
- Integrate the trigonometric functions.
- Perform integration by parts.
- Perform integration by substitution.
- Perform integration by use of tables.

RECOMMENDED TEXTS

Clar and Hart, Mathematics for the Technologies. Englewood Cliffs, NJ: Prentice-Hall.

Paul and Shaevel, Essential of Technical Mathematics with Calculus. Englewood Cliffs, NJ: Prentice-Hall.

Washington, Allyn J., Basic Technical Mathematics with Calculus. 3rd ed., Benjamin Cummings.

PHYSICS I

COURSE DESCRIPTION

A practical approach toward the concepts of force, work, rate, and power is presented in Physics I. Students are shown, by classroom demonstration, how these four concepts are applied to the four energy systems - mechanical, fluidal, electrical, and thermal - and then will perform laboratory experiments that relate each concept to the four energy systems.

PREREQUISITE: Admission of Program

CO-REQUISITE: Algebra

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introduction	5	5
A. Identification of energy systems		
B. Review of simple mathematics		
C. Review of basic concepts of physics		
II. Force	10	10
A. Mechanical systems		
1. linear force		
2. units of mass and force		
3. forcelike quantities		
4. torque		
B. Fluidal systems		
1. pressure		
2. density/pressure relationships		
C. Electrical systems		
1. electromotive force (EMF)		
2. methods of producing an EMF		
D. Thermal systems		
1. temperature difference		
2. temperature scales		
III. Work	10	5
A. Mechanical systems		
1. mechanical work, translational		
2. mechanical work, rotational		
B. Fluidal systems		
1. pressure/volume relationships		

	Student Contact Hours	
	Class	Laboratory
2. energy considerations		
C. Electrical systems		
1. charge movement and EMF		
2. conversion factors for electrical systems		
3. current		
D. Thermal systems		
1. heat flow rate		
2. heat measure		
3. change of state		
IV. Rate	10	5
A. Mechanical system		
1. speed and velocity, linear motion		
2. acceleration, linear		
3. rotational motion, angular velocity		
4. angular acceleration		
B. Fluidal systems		
1. volume flow rate		
2. mass flow rate		
C. Electrical systems		
1. current		
2. AC/DC		
D. Thermal systems		
1. heat energy transfer		
2. heat flow rate		
V. Power	5	5
A. Power equations		
1. power defined		
2. basic equation form		
B. Efficiency		
C. Mechanical systems		
1. translational		
2. rotational		
D. Fluidal systems		
E. Electrical systems		
F. Thermal systems		

STUDENT COMPETENCIES

- Define the following physical quantities and, where applicable, state their units in both SI (International System of Units) and English System of Units:
  - Force
  - Torque
  - Pressure
  - Voltage
  - Temperature Difference
- Given two or more mechanical forces acting along the same line, determine the resultant force.

- Given two of the following quantities in a mechanical rotational system determine the third:
    - Force
    - Lever Arm
    - Torque
- Given two of the following quantities in a fluid system, determine the third:
    - Force
    - Area
    - Pressure
- Given two of the following quantities in a fluid system, determine the third:
    - Pressure
    - Height of fluid
    - Weight density
- Given two or more voltage sources connected in series, determine the resultant voltage.
- Given a temperature in either degrees Celsius or degrees Fahrenheit, determine the equivalent temperature on the other scale.
- Describe how pressure in fluidal systems, voltage in electrical systems, and temperature difference in thermal systems are similar to force and torque in mechanical systems.
- Describe the conditions that must be met for equilibrium in each of the following energy systems:
    - Mechanical
    - Fluidal
    - Electrical
    - Thermal
- Define work and energy in general terms that apply to any energy system, and distinguish work from energy in the following systems:
    - Mechanical translational
    - Mechanical rotational
    - Fluidal
    - Electrical
    - Thermal
- Define the following units of work and energy
    - Foot-Pound
    - Calorie
    - British thermal unit
    - Joule
- Define the following terms and explain their usefulness in determining work done:
    - Radian (mechanical system)
    - Current(electrical system)
    - Specific heat (thermal system)
    - Heat capacity (thermal system)
- Given two of the following quantities in a mechanical translational system, determine the third:
    - Force
    - Displacemnt
    - Work

- Given two of the following quantities in a mechanical rotational system, determine the third:
    - Torque
    - Angular displacement
    - Work
- Given two of the following quantities in a fluidal system, determine the third:
    - Pressure differnece
    - Volume displace
    - Work
- Given two of the following quantities in an electrical system, determine the third:
    - Voltage
    - Charge transferred
    - Work
- Given the temperature difference across a uniform thickness of a substance, the dimensions of the substance, and its thermal conductivity, calculate the heat flow rate through the substance.
- Given two of the following quantities in a thermal system, determine the third:
    - Temperature change of object
    - Heat capacity of object
    - Work (heat energy transferred)
- Define and give examples of:
    - Latent heat
    - Sensible heat
- State the general equation for work, and explain how it applies to each of the following energy systems:
    - Mechanical translational
    - Mechancial rotaitonal
    - Fluidal
    - Electrical
    - Thermal
- Define the following rates and, where applicable, express their basic units both in SI and English systems of units:
    - Speed and velocity
    - Acceleration
    - Angular velocity
    - Angular acceleration
    - Volume flow rate
    - Mass flow rate
    - Electric current
    - Heat flow rate
- In a linear mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
    - Displacement, elasped time, velocity
    - Initial velocity, final velocity, elapsed time, acceleration
    - Mass, force, acceleration

- In a rotational mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
    - Angular displacement, elapsed time, angular velocity / Initial angular velocity, final angular velocity, elapsed time, angular accelaration
- In a fluidal system, given all the quantities except one in each of the following groups, determine the unknown quantity:
    - Volume of fluid moved, elapsed time volume flow rate / Mass of fluid moved ,elapsed time, mass flow rate
- Given two of the following quantities in an electrical system, determine the third:
    - Charge transferred
    - Elapsed time
    - Current
- Given two of the following quantities in a thermal system, Determine the :
    - Heat energy transferred
    - Elapsed time
    - Heat flow rate
- State the general equation for rate, and explain how it applies to each of the following energy systems:
    - Mechancial translational
    - Mechanical rotational
    - Fluidal
    - Electrical
    - Thermal
- Define "power" as it applies, in general, to all energy systems; and equations that relate work,elapsed time, force, and rate to power in these energy systems:
    - Mechanical system
    - Fluidal system
    - Electrical system
- List for each energy system the SI and English units used to define power.
- Given any two of the following quantities in any energy system, determine the third:
    - Work(or force-like quantity x displacement - like quantity)
    - Elapsed time
    - Power
- Given any two of the following quantities in any energy system, determine the third:
    - Force-like quantity
    - Rate
    - Power
- Define the following terms:
    - Input power
    - Output power
    - Efficiency

RECOMMENDED TEXTS

Cord, Unified Technical Concepts. Waco, Tx: Center for Occupational Reasearch and Development, 1980.

Dierauf, Edward J.,Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

- In a rotational mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Angular displacement, elapsed time, angular velocity / Initial angular velocity, final angular velocity, elapsed time, angular accelaration
- In a fluidal system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Volume of fluid moved, elapsed time volume flow rate / Mass of fluid moved ,elapsed time, mass flow rate
- Given two of the following quantities in an electrical system, determine the third:
  - Charge transferred
  - Elapsed time
  - Current
- Given two of the following quantities in a thermal system, Determine the :
  - Heat energy transferred
  - Elapsed time
  - Heat flow rate
- State the general equation for rate, and explain how it applies to each of the following energy systems:
  - Mechancial translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Define "power" as it applies, in general, to all energy systems; and equations that relate work,elapsed time, force, and rate to power in these energy systems:
  - Mechanical system
  - Fluidal system
  - Electrical system
- List for each energy system the SI and English units used to define power,
- Given any two of the following quantities in any energy system, determine the third:
  - Work(or force-like quantity x displacement - like quantity)
  - Elapsed time
  - Power
- Given any two of the following quantities in any energy system. determine the third:
  - Force-like quantity
  - Rate
  - Power
- Define the following terms:
  - Input power
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  - Efficiency

RECOMMENDED TEXTS

Cord, *Unified Technical Concepts.* Waco, Tx: Center for Occupational Reasearch and Development, 1980.

Dierauf, Edward J.,Jr., and Court, James E. *Unified Concepts in Applied Physics.* Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

PHYSICS II

COURSE DESCRIPTION

The second quarter of Physics builds on the foundation developed in the first quarter by presenting concepts of magnetism, resistance, energy, momentum, force transformers, and energy converters. The course balances theory related to these six concepts with practical hands-on experience in working with associated devices in the four energy systems (mechanical, fluidal, electrical, and thermal).

PREREQUISITE: Physics I

COREQUISITE: Trigonometry

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Magnetism	5	5
A. Magnetic theory		
B. Magnetic fields and flux		
C. Comparison of magnetic and electric circuits		
II. Resistance	10	5
A. Mechanical systems		
1. dry friction		
2. static and kinetic friction		
B. Fluidal systems		
1. fluid resistance in pipes		
2. viscosity		
C. Electrical systems		
1. Ohm's Law		
2. resistivity of conductors		
D. Thermal systems		
1. thermal resistance		
2. insulation		
III. Potential and Kinetic Energy	10	5
A. Mechanical systems		
1. translational		
2. rotational		
B. Fluidal systems		
1. volume/mass conversion		
2. Bernoulli's equation		
C. Electrical systems		
1. charge relationships		

	Student Contact Hours	
	Class	Laboratory
2. capacitors		
D. Thermal systems		
IV. Momentum	5	5
A. Linear momentum		
B. Impulse and momentum change		
C. Angular momentum		
D. Momentum in fluidal systems		
E. Conservation of momentum		
V. Force Transformers	5	5
A. Principles of force transformers		
B. Mechanical systems		
1. the pulley		
2. the lever		
3. the inclined place		
4. the screw		
5. the wheel and the axle		
C. Fluidal systems		
1. the hydraulic lift		
2. mechanical advantage of a hydraulic lift		
D. Electrical systems - electrical transformers		
VI. Energy Converters	5	5
A. General considerations and background		
B. Converters of mechanical input energy		
C. Converters of fluidal input energy		
1. mechanical output energy		
2. electrical output energy		
D. Converters of electrical input energy		
1. mechanical output energy		
2. thermal output energy		
3. optical output energy		
E. Converters of thermal input energy		
1. mechanical output energy		
2. thermal output energy		
3. optical output energy		
F. Converters of optical input energy		
1. electrical output energy		
2. thermal output energy		

STUDENT COMPETENCIES

- Determine the direction and strength of a magnetic field.
- Examine how the concepts of force, parameter, rate, and resistance apply to magnetic circuits.
- List and describe different types of magnetic material.
- Calculate magnetic field strength, or magnetic flux of an area.
- Explain the effects magnetism has in each of the energy systems.
- Describe the effect of magnetic forces exerted on moving charged particles in a magnetic field.
- Compare simple magnetic and electric circuits using the unified concepts.
- Given two of the following quantities in a fluid system determine the third:
    - Pressure
    - Height of fluid
    - Weight density
- Given two or more voltage sources connected in series, determine the resultant voltage.
- Given a temperature in either degrees Celsius or degrees Fahrenheit, determine the equivalent temperature on the other scale.
- Describe how pressure in fluidal systems, voltage in electrical systems, and temperature difference in thermal systems are similar to force and torque in mechanical systems.
- Describe the conditions that must be met for equilibrium in each of the following energy systems:
    - Mechanical
    - Fluidal
    - Electrical
    - Thermal
- Define work and energy in general terms that apply to any energy system, and distinguish work from energy in the following systems:
    - Mechanical translational
    - Mechanical rotational
    - Fluidal
    - Electrical
    - Thermal
- Define the following units of work and energy
    - Foot-Pound
    - Calorie
    - British thermal unit
    - Newton-Meter Joule
- Define the following terms and explain their usefulness in determining work done:
    - Radian (mechanical system)
    - Current (electrical system)

  - Specific heat(thermal system)
  - Heat capacity(thermal system)
- Given two of the following quantities in a mechanical translational system, determine the third:
  - Force
  - Displacement
  - Work
- Given two of the following quantities in a mechanical rotational system, determine the third:
  - Torque
  - Angular displacement
  - Work
- Given two of the following quantities in a fluidal system, determine the third:
  - Torque
  - Angular displacemnt
  - Work
- Given two of the following quantities in an electrical system, determine the third:
  - Voltage
  - Charge transferred
  - Work
- Given the temperature difference across a uniform thickness of a substance, the dimensions of the substance, and its thermal conductvity, calculate the heat flow rate through the substance.
- Given two of the following quantities in a thermal system, determine the third:
  - Temperature change of object
  - Heat capacity of object
  - Work (heat energy transferred)
- Define and given examples of:
  - Latent heat
  - Sensible heat
- State the general equation for work, and explain how it applies to each of the following energy systems:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
- Define the following rates and , where applicable, express thier basic units both in SI and English systems of units:
  - Speed and velocity
  - Acceleration
  - Angular velocity
  - Angular acceleration
  - Volume flow rate
  - Mass flow rate
  - Electric current
  - Heat flow rate

- In a linear mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Displacement, elapsed time,velocity
  - Initial velocity, final velocity, elapsed time, acceleration
  - Mass, force, acceleration
- In a rotational mechanical system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Angluar displacement, elapsed time, angular velocity/ Initial angular velocity, final angular velocity, elapsed time, angular acceleration
- In a fluidal system, given all the quantities except one in each of the following groups, determine the unknown quantity:
  - Volume of fluid moved, elapsed time volume flow rate, mass fluid moved, elapsed flow rate
- Given two of the following quantities in an electrical system, determine the third:
  - Charge transferred
  - Elapsed time
  - Current
- Given two of the following quantities in a thermal system, determine the third:
  - Heat energy transferred
  - Elasped time
  - Heat flow rate
- Define resistance in a general way, and state the final form of the energy expended when a forcelike quantity does work to overcome resistance in an energy system.
- Calculate the magnitudes of starting and sliding frictional forces, given the mass or weight of the object, the coefficients of friction, and the angle of incline.
- Given the two of the following quantities in fluidal, electrical, and thermal systems, determine the third:
  - Forcelike quantity
  - Rate
  - Resistance
- Describe the difference between laminar and turbulent flow.
- State the factors contributing to fluid resistance in pipes.
- State the factors contributing to thermal resistance of objects.
- Describe with the use of graphs the definition of resistance as the ration of forcelike quantity to rate in fluidal, electrical, and thermal systems. Include the units of forcelike quantity, rate, and resistance for each system.
- State the fundamental difference between sliding

friction and resistance as it applies to fluidal, electrical, and thermal systems.

- Define potential energy, kinetic energy, and conservation of enrgy by using examples from mechanical systems.
- Given any two of the quantities in the following groups, determine the third:
  - Mass, velocity, kinetic energy
  - Mass, height, potential energy
  - Spring constant, spring displacement, potential energy / Moment of inertia, angular velocity, kinetic energy / Capacitance, voltage, potential energy
- Given Bernoulli's equation and the height of liquid in a tank, determine the exit velocity at the bottom of the tank if ther is no fluid friction.
- List and describe the three processes that transfer thermal energy.
- Discuss the conservation of energy as it applies to fluidal, electrical, and thermal systems.
- Define the following terms; state the appropriate units in the mk/s system (SI) and t cg/s system; and give the equation for each:
  - Linear momentum
  - Angular momentum
  - Impulse
  - Angular impulse
  - Moment of inertia
- Given two of the following quantities, determine the third:
  - Mass of an object
  - Velocity of the object
  - Momentum of the object
- Given all the following quanities, determine the third:
  - Moment of inertia of an object
  - Angular velocity of the object
  - Angular momentum of the object
- Given two of the following quantities except one describing a linear collison, determine the unknown quantity:
  - Mass of first object
  - Initial velocity of first object
  - Final velocity of first object
  - Mass of second object
  - Initial velocity of second object
  - Final velocity of second object
- Explain the following concepts in a short paragraph each:
  - Consevation of linear momentum
  - Conservation of angular momentum
- Use a given equation to calcuate the force produced on one blade of a reaction turbine, given the velocity of fluid and the mass of fluid per unit time striking the blade.

- Describe specific force transformers in the mechanical translational, mechanical rotational, fluidal, and electrical systems; and discuss their fundamental similarity as transformers of forcelike quantities.
- Define the following terms:
  - Ideal mechanical advantage
  - Actual mechanical advantage
  - Efficiency
- Calculate the ideal mechanical advantage of a specific pulley, lever, screw, wheel and axle, hydraulic press or lift, and electrical transformer.
- Calculate the change in current in an ideal electrical transformer.
- Discuss how the role of resistance in a transformer dissipates energy input and reduces efficience.
- Describe the power input and power output characterisitcs of a transformer that operates continuously.
- Describe energy converters in general terms that apply to all energy-conversion devices.
- Describe the operation of the following energy converters:
  - Vane pump
  - Turbine
  - Electric generator
  - Electric motor
  - Electric heater
  - Internal combustion engine
  - Boiler
  - Solar collector
- Given two of the following quanities, determine the third:
  - Input energy
  - Output energy
  - Efficiency
- Given the efficiency of all the energy converters used in an energy conversion system, determine the overall system efficiency.

RECOMMENDED TEXTS

Cord, Unified Technical Concepts. Waco, TX: Center for Occupational Research and Development, 1980.

Dierauf, Edward J., Jr., and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

PHYSICS III

COURSE DESCRIPTION

This third quarter of Physics will provide the student with practical knowledge of sound scientific principles behind devices and components addressed in four concepts; transducers, energy transfer and storage, vibration and waves, and radiation. Practical hands-on experience with devices common to many technologies is offered in the laboratory.

PREREQUISITE: Trigonometry, Physics II

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Transducers	5	5
A. Basic concepts		
B. Self excited transducers		
C. Externally excited transducers		
II. Energy Transfer and Storage	10	5
A. Basic considerations		
1. thermal cooling		
2. rotational		
B. Mechanical systems		
1. translational		
2. rotational		
C. Fluidal systems		
D. Electrical systems		
E. Thermal systems		
III. Vibrations and Waves		15
A. Oscillating systems		
1. simple harmonic motion		
2. oscillating systems with resistance		
3. forced oscillations		
4. resonance		
B. Types of waves		
1. transverse		
2. longitudinal		
C. Wave characteristics		
1. wave velocity		
2. the wave equation		
3. superposition		
4. standing waves		
5. interference		
D. Wave motion as a unifying concept		
1. mechanical systems		

	Student Contact Hours	
	Class	Laboratory
2. fluidal systems		
3. electrical waves		
IV. Radiation	10	10
A. Electromagnetic radiation		
B. Light		
C. Optical instruments		
D. Waves and particles		
E. particle radiation		

STUDENT COMPETENCIES

- In a short paragraph, define a transducer. Include a distinction between those transducers that require external energy sources and those that do not.
- Describe the operation of the following transducers:
  - Strain gage
  - Accelerometer
  - Microphone
  - Turbine flowmeter
  - Barometer
  - Meter movement
  - Thermocouple
  - Thermistor
  - Bimetallic strip
  - Photoconductive cell
  - Photovoltaic cell
- Define the following terms:
  - Steady state
  - Transient
  - Damping
  - Time constant
  - Half-life
  - Decay constant
- Draw and label a graph showing an exponentially-decaying function. Include on the graph the time constants T1/2 and T1/e = = . also write an equation for the function shown on the graph.
- Given the initial temperature of a hot body, the ambient temperature of its surroundings, and the thermal time constant of the system, determine the temperature of the body after a specified time interval.
- Given the number of radioactive atoms in a sample and the decay constant, determine the number of atoms remaining after a specified time interval.
- Given the values of resistance, capacitance, and applied voltage in an RC electrical circuit, determine the time constant for the circuit, the time required for the capacitor voltage to reach 99% of the applied voltage, and the circuit current and capacitor voltage after a

specified time interval.

- Explain how the concept of time constants can be applied to the following energy systems; give a specific example in each case:
  - Mechanical translational
  - Mechanical rotational
  - Fluidal
  - Electrical
  - Thermal
  - Optical
  - Nuclear
- Solve problems involving simple harmonic motion.
- Describe damping phenomena in oscillating systems with resistance.
- Describe systems oscillating under the influence of an energy source.
- Distinguish between longitudinal and transverse waves by giving at least two examples of each types and by drawing and labeling a sketch of each.
- Define the following terms associated with waves and wave motion:
  - Propagating medium
  - Wavelength
  - Frequency
  - Period
  - Displacement
  - Amplitude
  - Phase
  - Standing wave
  - Constructive interference
  - Destructive interference
  - Beats
- Calculate the wavelength of a wave, given its velocity and frequency.
- Interpret the following equation, explaining the significance of each symbol:

  $y = A \sin 2 (- ft)$.
- Explain the meaning of the expression, "The current leads the voltage by a given phase angle " by using sine-wave sketches of both current and voltage.

Describe the superposition principle.

- Describe wave phenomena in each of the following energy sytems:
  - Mechanical
  - Fluidal
  - Electrical
- Describe in one or two sentences the basic properties of each of the following types of radiation:
  - Sound
  - Light
  - Alpha and beta particles
- Define electromagnetic radiation (radiant energy), and describe a simple experiment that illustrates how electromagnetic radiation can be created.

- List the frequencies in the electromagnetic spectrum from wavelength Em waves of AC power (60 hertz) to gamma rays (10 hertz), including each major part - radio, FM, television, radar, microwave, infrared, visible, ultraviolet, X-ray, and gamma ray.
- Given the equation $v + \lambda f$ - relating wave speed, wavelength and frequency - determine the radiation frequency for any part of the electromagentic spectrum.
- Given the equation $E = hf$ or $E = h\,c/e$, determine the energy of different waves in Em spectrum.
- Describe qualitatively the nature of an electromagnetic wave in terms of electric and magnetic fields; state what is always required to generate an EM wave; and explain how EM waves are propagated through empty space without benefit of an elastic medium.
- Describe a photon, and explain why both wave and particle-like (photon) phenomena are required to describe interaction of Em radiation with matter. Give examples in which the wave character is most useful in describing Em radiation and in which the photon character is most useful.
- Explain what is meant by the inverse square law and how this law is used to describe the fall-off of EM radiation propagating from a small source.
- Define polarization, and explain what is meant by polarized Em radiation - in particular polarized light.
- Define visible radiation, and determine it's limits numerically in terms of wavelength, frequency, and energy.
- Describe the reflection and refraction of EM radiation - especially light - and set up an experiment to verify the two laws.
- Differentiate between alpha and beta radiation and gamma radiation.
- Briefly explain each of the three parts in the symbol $_{92}U^{238}$
- Given the appropriate equipment, illustrate and verify the inverse square law of EM radiation in the visible region.
- Given the appropriate equipment, produce and detect polarized light in the microwave region.

RECOMMENDED TEXTS

CORD, Unified Technical Concepts. Waco TX: Center for Occupational Research and Development, 1980.

Dierauf, Edward J., Jr. and Court, James E. Unified Concepts in Applied Physics. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1979.

TECHNICAL COURSES

A-C CIRCUITS

COURSE DESCRIPTION

This course provides the student with the knowledge and skills to analyze basic A-C circuits. The course includes the following main topics: Magnetism, Inductance, Alternating current, Reactance, Impedance, and Admittance.

PREREQUSIITE: DC Circuits, Algebra

CO-REQUISITE: Trigonometry, Phusics I

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Magnetism A. Magnetization curves B. Permability from the BH curve C. Hysteresis D. Eddy current E. Magnetic shielding F. Magnetic circuits	5	3
II. Inductance A. Faraday's law B. Lenz's law C. Counter emf D. Time constant	6	6
III. Alternating Current A. The sine wave B. Peak values C. Instantaneous values of voltage amd current D. The radian E. Rms Values F. Average values	7	6
IV. Reactance A. Inductive reactance B. Capacitive reactance C. Vector algebra	6	6
V. Impedance A. RLC series circuits B. RLC parallel circuits C. Admittance D. Conductance and susceptance E. Power factor	10	6

	Student Contact Hours	
	Class	Laboratory
VI. Impedance networks	3	3
A. Loop equations		

STUDENT LABORATORIES

- Analyze magnetic circuits.
- Operation of an oscilloscope.
- Determine the peak value , RMS value, and peak-to-peak value of a sinewave using an oscilloscope.
- Plot the response curve of a series RL and RC network.
- Plot the response curve of a parallel RC and RL network.
- Analyze A-C circuits using the Thevinin theorem.
- Determine the total current in a series RC, RL and RLC circuit.
- Determine real and apparent power in a series RLC circuit.
- Use loop equations to solve impedance networks.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Operate an oscilloscope.
- Determine peak value, instantaneous value, average value, and RMS value of a sine wave.
- Measure voltage and current in a series RLC circuit and parallel RLC circuit.
- Determine the total impedance and admittance of a series and parallel RLC circuit.
- Use loop equation to solve impedance networks.

RECOMMENDED TEXTS

Boylestad, Robert D. *Introductory Circuit Analysis,* Fourth Edition, Indianapolis, In: Bobbs Merrill, 1981.

Jackson, Herbert W., *Introductory to Electric Circuits,* Fifth Edition, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1981.

ANTENNAS, TRANSMISSION LINES, AND MICROWAVES

COURSE DESCRIPTION

This course is designed to provide a study in transmission, propagation, and reception of electromagnetic energy. Microwave theory is also emphasized.

PREREQUISITE: Communication Systems

COREQUISITE: None

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. General Transmission Line Theory	10	10
A. General transmission line equations		
B. Reflection coefficient		
C. Non-power and power consuming load		
D. Input impedance equation		
E. SWR		
F. Smith chart		
G. The attenuation constant		
H. Balanced-unbalanced and unbalanced-balanced transformation		
I. Quarter-wave transformers		
J. Single-stub impedance matching		
II. Antennas	15	10
A. Electromagnetic wave propagation		
B. Antenna parameters		
C. Basic radiators		
D. Arrays		
E. Microwave antennas		
F. Antenna measurements		
III. Microwave	15	10
A. Frequency range		
B. Waveguides		
C. Cavity resonators		
D. Coupling of waveguide energy		
E. Directional couplers		
F. Tuners		

G. Hybrid T
H. Modes of Operation
I. Microwave Tubes
J. Solid-State Microwave Devices

STUDENT LABORATORIES

- Use a time domain reflectometer to determine the type of transmission line termination.
- Determine the electrical distances between E max and E min with an X-band slotted line.
- Given an x-band slotted line, determine the SWR on the line for termination of a short, open and Z .
- Using a field strength meter determine the radiation patterms, in both planes, of a half-wave dipole and monopole.
- Given an x-band transmitter, horns, and a detector, analyze the effects of space attenuation, polarization, and radomes.
- Using a satellite receiving antenna, determine and adjust the antennas's position to receive data from at least 3 satellites.
- Given a field strength meter, determine the standing wave patterns of voltage and current on a half-wave dipole and monopole.
- Given an x-band transmitter, waveguide, detector, slotted line and slide tower vary the position of the tuner to analyze its effect on the SWR.
- Given an x-band transmitter, waveguide, detector, and flap attenuator, vary the attenuator to determine the effect on the SWR and transmitted power.
- Given a waveguide system, set the system up to transmit and receive data in accordance with specificaiton provided by the instructor.

STUDENT COMPETENCIES

At the conclusion of this course, the student should be able to:

- Calculate input impedance anywhere on the transmission line given essential data.
- Calculate voltage and current reflection coefficient given the characteristic impedance of the line and its load impedance.
- Calculate the characteristic impedance of a quarter-wave transformer given essential data.
- Calculate the length and position of a matching stub given essential data.

- Calculate space attenuation given essential data.
- Define inverse-square law.
- Determine the minimum distance to far field.
- Define antenna gain.
- Determine attenuation due to absorption.
- Define propagation factor.
- Determine the E field and H field intensity.
- Define antenna loading.
- Define ERP.
- Design a yag-uda antenna.
- Calculate the power gain and beamwidth of a microwave dish antenna.
- Define polarization.
- Sketch the radiation patterns of half-wave dipole, monopole, marconi, yagi, folded dipole, broadside array, and microwave dish.
- Describe the operation of a slotted line.
- Describe the operation of a flap antennuator.
- Describe the operation of a slide tuner.
- Sketch the standing wave patterms on a half-wave dipole and monopole.

RECOMMENDED TEXTS

Blake, Lamont V., Antennas, New York,NY John Wiley & Sons, 1980

McMilley, Gary, Modern Electronic Communication, Englewood Cliffs, NJ, Prentice Hall, 1981

CIRCUIT ANALYSIS

COURSE DESCRIPTION

This course provides the student with the knowledge and skills to analyze complex circuits. The course includes the following main topics: analysis of complex circuits, Resonant circuits, transformer action and three-phase systems.

PREREQUISITE: AC Circuits, Trigonometry

CO-REQUISITE: Analytic Geometry and Calculus

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Analysis of Complex Networks	15	6
A. Superposition theorem		
B. Thevenin's theorem		
C. Norton's theorem		
D. Nodal analysis		
E. Impedance bridges		
F. Delta-wye transformation of complex networks		
G. Transients		
II. Resonance	10	6
A. Series resonant circuits		
B. Parallel resonant circuits		
C. L/C ratios		
D. Resonant response curves		
E. Q rise in voltage and current		
III. Transformers	5	6
A. Iron-core transformers		
B. Air-core transformers		
C. Tranformation ratio		
D. Reflected impedance		
E. Loading		
F. Efficiency		
IV. Three-Phase Systems	10	9
A. Polyphase systems		
B. Double-subscript notation		
C. Balanced three-phase systems		
D. Unbalanced three-phase systems		
E. Delta-connected system		
F. 4-wire wye-connected system		

STUDENT LABORATORIES

- Analyze complex impedance networks using the circuit theorems.
- Measure the change in primary current as the secondary load is varied.
- Construct a response curve for a series resonant circuit.
- Construct a response curve for a parallel resonant circuit.
- Measure the total current through a series resonant circuit.
- Analyze a delta to wye transformer action.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Analyze complex networks using the circuit theorems.
- Analyze delta-wye transformation of complex networks.
- Determine the difference between air-core and iron-core transformers and where each might be used.
- Analyze transformer action.
- Determine reflected impedance values.
- Determine transformation ratio.
- Analyze resonant circuits.
- Analyze 3-phase systems.

SUGGESTED TEXTS

Boylestad, Robert D., Introductory Circuit Analysis, Fourth Edition, Indianapolis, IN: Bobbs Merrill, 1981.

Jackson, Herbert W., Introduction to Electric Circuits, Fifth Edition, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1981.

CONTROL SYSTEM COMPONENTS

COURSE DESCRIPTION

This course will provide the student with a broad knowledge of control systems and an introduction to robotics. Practical examples of the components studied provide a working understanding of theoretical concepts.

PREREQUISITE: Digital Application

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Introduction to Control Systems	1	2
A. Purpose of control systems		
B. Implementation of control systems		
C. Introductory control system theory		
II. Sensors	3	2
A. Mechanical parameter sensors		
1. motion sensors		
2. position sensors		
3. force sensors		
B. Fluid parameter sensors		
1. pressure sensors		
2. level sensors		
3. flow sensors		
C. Temperature sensors		
1. fundamentals of temperature measurement		
2. filled system thermometers		
3. bimetallic temperature sensors		
4. resistive temperature sensors		
5. thermocouples		
6. pyrometers		
D. Miscellaneous sensors		
1. light sensors		
2. radiation and thickness sensors		
3. humidity and moisture sensors		
4. time variables		
5. consideration for sensor selection		

III. Theory of Measurements	3	2
A. Accuracy and standards		
B. Typical sensor outputs		
C. Voltage, frequency, resistance outputs		
IV. Control System Theory	6	2
A. Open loop control		
B. Close loop control		
1. on-off control		
2. proportional control		
3. integral control		
4. derivative control		
5. PID control		
V. Controller Hardware	5	3
A. Analog electric controller		
B. Digital controller		
C. Pneumatic controller		
D. Fluidic computing elements		
VI. Conversion Techniques	5	3
A. Digital to analog conversion		
B. Analog to digital conversion		
C. Sample and hold function		
D. Application to A/D convertors		
VII. Actuators	2	2
A. Electromechanical actuators		
B. Hydraulic-pneumatic actuators		
VIII. Programmable Controllers	6	5
A. Relax ladder diagrams		
B. Programmable controllers vs relays		
IX. Introduction to Robotics	3	5

STUDENT LABORATORIES

- Perform measurements using a variety of sensors.
- Construct and analyze open-loop and close-loop system.
- Design and construct A/D and D/A converter.
- Program a programmable controller.
- Control an automated process via a microprocessor.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Understand the fundamentals of control systems.
- Describe and analyze mechanical sensors.
- Describe and analyze temperature sensors.
- List and describe miscellaneous sensors.
- Describe the theory of measurements.
- Explain and analyze system theory.
- List and describe controller hardware.
- Explain and analyze conversion techniques, actuators, etc.
- Operate a programmable controller.

RECOMMENDED TEXTS

Hunter, Ronald P. Automated Process Control System. Prentice-Hall, Inc.

COMMUNICATION CIRCUITS

COURSE DESCRIPTION

This course provides the knowledge and skills necessary to produce an understanding of basic circuits used in communications. Emphasis is placed on coupling methods and circuit analysis. AM transmission and reception will be emphasized.

PREREQUISITE: Electronic Devices, Circuit Analysis

CO-REQUISITE: Semi-Conductor Analysis

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Power Supplies (DC)	4	3
A. Rectifier circuits		
B. Filter circuits		
C. Voltage multipliers		
D. Voltage regulators		
II. Resonant Circuits	4	3
A. Series-resonant circuits		
B. Parallel-resonant circuits		
C. R-F filter circuits		
III. Noise Factors	2	0
A. Description of noise		
B. Noise calculations		
IV. RF Voltage (or small-signal) Amplifiers	6	3
A. Impedance-coupled RF amplifiers		
B. Single-tuned transformer-coupled RF amplifiers		
C. Double-tuned transformer-coupled RF amplifiers		
D. High-frequency circuits		
V. RF Power Amplifiers	4	3
A. Vacuum-tube class-C amplifiers		
B. Neutralization in class-C amplifiers		
C. Class-B linear amplifiers		
D. Transistor RF power amplifiers		

	Student Contact Hours	
	Class	Laboratory
E. Multistage considerations		
VI. RF Oscillators	4	3
A. General considerations		
B. Basic oscillator circuits		
C. Crystal oscillators		
D. Bipolar transistor crystal oscillators		
VII. Amplitude Modulation--Transmitters	6	6
A. Other modulation circuits		
B. Transistor modulators		
C. Operational checks		
D. Basic transmitters		
VIII. Demodulation of AM Waves	4	3
A. Basic principles		
B. The diode detector		
C. Other types of AM detectors		
IX. AM Receivers	6	6
A. Receiver comparison factors		
B. Tuned radio-frequency (TRF) receivers		
C. Superheterodyne receiver		
D. Receiver alignment		

STUDENT LABORATORIES

- Construct and analyze half wave, full wave and voltage double rectifier circuits.
- Construct and investage the operation and characteristics of series and short voltage regulator circuits.
- Construct series and parallel L-C Tank circuits and observe oscillation and band width.
- Construct a typical RF amplifier circuit and measure the circuit papameters.
- Construct and analyze L-C and crystal oscillator circuits.
- Construct and measure the gain and band width of multistage amplifiers using different coupling methods.
- Construct a simple AM transmitter and measure the percent of modulation.
- Construct and properly adjust a balanced modulator.
- Construct and analyze a diode AM detector.
- Perform alignment procedures on an AM superheterodyne receiver.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- identify three types of basic power supply circuits, and state the characteristics of each.
- Identify, construct and determine the characteristics of a series and a parallel resonant circuit.
- List one advantage and disadvantage of three types of coupling circuits.
- Given a schematic disgram of a typical BJT RF amplifier, identify the type of coupling employed, the class of operation, and probable uses.
- Define neutralization and describe one method of neutralizing an amplifier.
- Draw a schematic diagram of three different oscillator circuits and identify the component(s) which comprise the feedback network.
- Given a modulated transmitter waveform (AM), specify the percent of modulation.
- Describe the operation of an AM detector.
- Draw a block diagram of a superheterodyne receiver (AM), and describe the purpose of each stage.

RECOMMENDED TEXTS

DeFrance, J.J. , Communications Electronics, 2nd Edition. Holt, Rinehart, and Winston, Inc.

Electronic Circuits, Benton Harbor, MI: Heathkit Learning Publications.

Electronic Communcations, Benton Harbor, MI: Heathkit Learning Publications.

Roddy, Dennis & Collen, John. Electronic Communications. Reston, VA: Reston Publishing Co.

COMMUNICATION SYSTEMS

COURSE DESCRIPTION

This course provides topics necessary to give the student an understanding of basic communication systems. Emphasis is placed on the FM, SSB, and video systems. The systems approach is emphasized.

PREREQUISITE: Communication Circuits, Semi-Conductor Analysis

CO-REQUISITE: Linear Integrated Circuits

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Single-Side-Band Communications	10	6
A. SSB characteristics		
B. The balanced modulator		
C. SSB filters		
D. SSB transmitter		
E. SSB demodulation		
F. SSB receivers		
G. Frequency synthesis		
II. FM Transmission	12	9
A. Angle modulation		
B. Simple FM generator		
C. Fm analysis		
D. Noise suppression		
E. Direct FM generation		
F. Indirect FM		
G. Stereo FM		
H. FM transmissions		
III. FM Reception	8	9
A. FM-RF amplifiers		
B. Limiters		
C. Discriminators		
D. The PLL		
E. Stereo demodulation		
F. FM recievers		
IV. Video Transmission and Reception	10	6
A. Transmitter principles		
B. Television receivers		
C. IF amplifiers		
D. Video section		

E. SYNC
F. Deflection
G. Color transmission

STUDENT LABORATORIES

- Analyze the responses of the ring balanced modulator to various signals.
- Analyze SSB and DSB modulation.
- Analyze the mechanical filter.
- Analyze a single side band system's response.
- Use the spectrum analyzer to study the power distribution in an FM composite signal.
- Analyze the operation of an FM modulator.
- Analyze the response of an FM system.
- Design a PLL using integrated circuits.
- Analyze FM discriminator circuits.
- Use the oscilloscope to analyze a composite video signal.
- Design a frequency systhesis circuit using integrated circuits.

STUDENT COMPETENCIES

- Describe the operation of the balanced modulator.
- Describe the advantages of SSB over standard AM.
- Analyze the operation of a single side band transmitter.
- Design a frequency synthesis circuit.
- Define modulation index.
- Define deviation ratio.
- Analyze power distribution in a composite FM signal.
- Define guard bands.
- Define the frequency range of the standard broadcast FM channel.
- Describe the operation of various FM discriminators.
- Analyze FM stereo systems.
- Describe FM multiplexing.
- Define vestigial sideband transmission.
- Describe the operation of the vidicon.
- Define scanning and retrace.
- Define frame frequency.
- Describe vertical and horizontal sync pulses.
- Describe interlace scanning.
- Define burst.
- Analyze the composite video signal.
- Describe the operation of a basic T.V. transmitter.

RECOMMENDED TEXT

Modern Electronic Communication. Gary M. Miller, Prentice-Hall, Inc.

D-C CIRCUITS

COURSE DESCRIPTION

This course provides the student with the knowledge and skills to analyze basic D-C circuits. The course includes the following main topics: Scientific notation and unit conversions, Insulators, Conductors, Sources, Resistance, Work and power, Series and parallel circuits, Series-parallel circuits, and Equivalent circuits.

PREREQUISITE: Admission to program.

CO-REQUISITE: Algebra

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Introduction to Engineering Technology	4	6
A. SI units		
B. Scientific Notation		
C. Unit Conversions		
II. Introduction to Electricity	9	3
A. Insulators		
B. Conductors		
C. Sources		
D. Resistance		
E. Work and power		
III. Series and parallel circuits	8	9
A. Series circuits		
B. Parallel circuits		
C. Series-parallel circuits		
IV. D-C Circuit Theorems	15	9
A. Thevenin's theorem		
B. Norton's theorem		
C. Superposition theorem		
D. Millman's theorem		
E. Delta-wye transformations		
F. Nodal analysis		
G. Mesh analysis		
V. Capacitance	4	3
A. Capacitance reactance		
B. Charging and discharging		
C. Time constants		

STUDENT LABORATORIES

- Introduce the student to Engineering Technology.
- Introduction to instruments, measurement procedures, and saftey precautions.
- Measure D-C voltage, current and resistance in series circuits.
- Measure D-C voltage, current, and resistance in parallel circuits.
- Measure D-C voltage, current, and resistance in series-parallel circuits.
- Design a basic voltmeter and current meter.
- Analyze series-parallel circuits using circuit theorems.
- Determine capacitance values by use of discharge times.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Convert from one unit of measurement to another.
- Express decimal numbers in scientific notation.
- Use SI units
- Determine resistor values from their color code.
- Convert mechanical power to electrical power.
- Use a digital and analog VOM.
- Measure the current and voltage in a D-C series and parallel circuit.
- Use D-C circuit theorems to determine the total resistance, current and voltage in resistance networks.
- Plot the charging curve of a capacitor.

RECOMMENDED TEXT

Boylestad, Robert D. Introductory Circuit Analysis, Fourth Edition, Indianapolis, IN: Bobbs Merrill, 1981.

Jackson, Herbert W., Introduction to Electric Circuits, Fifth Editions, Englewood Cliffs, NJ: Prentice-Hall, Inc, 1981.

DIGITAL APPLICATIONS

COURSE DESCRIPTION

This course is designed to introduce the student to the microprocessor. Emphasis is placed on the microprocessor's hardware.

PREREQUISITE: Digital Electronics

CO-REQUISITE: Linear Integrated Circuits

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Computer Arithmetic	8	6
A. Algorithms		
B. Addition and subtraction		
C. Half and full adder		
D. Ones complement and twos complement addition / subtraction		
E. BCD		
F. Half and full substracters		
G. The ALU		
II. Memory Systems	12	9
A. Core memory		
B. Semi-conductor RAM		
C. The register concept		
D. RAM specifications		
E. Static RAM		
F. Dynamic MOS memory		
G. ROMS		
H. Shift register memory		
III. Interfacing	12	9
A. Bidirectional bus drivers		
B. Data communications line drivers and receivers		
C. Baud rate		
D. Level translators		
E. Serial and parallel		
IV. Hardware	8	6
A. The bus system		
B. Input and output ports		
C. Memory hierarchy		

	Student Contact Hours	
	Class	Laboratory
D. Prime memory		
E. Secondary and backup memory		
F. The CPU		
V. Processing Action	7	5
A. Introduction to programming and program processing		
B. Timing and multiplexing		
VI. Software	7	5
A. Data-transfer group		
B. Arithmetic group		
C. Logical group		
D. Assembly-language programming		
E. The conditional jump		
F. Interrupts		

STUDENT LABORATORIES

- Using integrated circuits, design a full adder.
- Construct a 4 bit parallel-in serial-out shift-right register and analyze its operation.
- Construct a 4 bit serial-in parallel-out shift-right-register and analyze its operation.
- Using integrated circuits design a pulse stretcher.
- Construct a digital-to-analog converter using the binary weighted ladder method.
- Construct an analog-to-digital converter.
- Construct a RAM circuit and analyze its operation.
- Given a microcomputer, determine its RAM Memroy size, type of addressing used, number of I/O ports, and clock speed.
- Design an assembly-language program to add ten numbers and using the mnemonics, execute the program on the microcomputer.
- Design a program to employ interrupts.

STUDENT COMPETENCIES

At the conclusion of this course, the student should be able to:

- Describe the operation of a half and full adder.
- Analyze the operation of a shift register.
- Describe an analog-to-digital converter.
- Analyze RAM operation.
- Interpret microcomputer specificaitions.
- Write programs using mnemonics and assembly language.

- Analyze ROM, PROM. EPROM, and EE PROM operation.
- Define software, hardware, and firmware.
- Describe the different addressing modes of the microcomputer.
- Describe a digital-to-analog convertor.

RECOMMENDED TEXTS

Bywater, Hardware/Software Design of Digital Systems, Prentice-Hall, 1979.

Coffran & Long, Practical Interfacing for Microprocessor Systems, Prentice-Hall, 1983.

Mano, Digital Logic and Computer Design, Prentice-Hall, 1979.

Tocci, Digital Systems: Principles and Applications, Prentice-Hall, 1980.

DIGITAL ELECTRONICS

COURSE DESCRIPTION

This course will introduce the student to basic digital circuits. Circuit analysis and troubleshooting techniques are also emphasized.

PREREQUISITES: Electronic Devices, Circuit Analysis

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Control Hours	
	Class	Laboratory
I. Introduction to Digital Techniques	5	10
A. Number systems		
B. Logic symbols and gates		
C. Basic Boolean operation		
D. Laws and theorems		
II. Integrated Logic Circuits	7	6
A. Types, classification, and identification		
B. Parameters and characteristics		
C. Logic families		
D. Practical logic circuits		
E. Simplification techniques		
F. Decision making logic elements		
III. Flip-Flops and Registers	7	6
A. D-type		
B. T-type		
C. JK		
D. Registers		
IV. Sequential Logic Circuits	7	6
A. Counters		
B. Shift registers		
C. Clocks and one shots		
D. Adders		
E. Subtractors		
V. Combinational Logic Circuits	7	6
A. Encoders		
B. Decoders		
C. Multiplexers		
D. Demultiplexers		
E. Code converters		

	Student Contract Hours Class	 Laboratory
VI. Memory Circuits	7	6

- A. Types of memories
- B. ROM
- C. RAM
- D. PROM

STUDENT LABORATORIES

- With the aid of Oscilloscopes, Voltmeters, Pulse Generators, Logic Probes, and Truth Tables construct and verify the function of the following Logic circuits:
  - AND
  - OR
  - NAND
  - NOR
  - Exclusive OR
  - Flip-Flops
  - Counters
  - Timers
  - Adders
  - Subtractors
  - Dividers

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Identify logic gates and functions.
- Connect various gates to produce combinational logic circuits.
- Diagram a basic logic system from a problem statement.
- Troubleshoot and repair basic logic and digital circuits.
- Interpret specifications from manufacturer's data sheets for digital circuits.
- Perform conversion between various number systems.
- Describe the characteristics of the most commonly used logic families.

RECOMMENDED TESTS

Digital Techniques, Book 1. Benton Harbor, MI: Heathkit Learning Publications.

Williams, Gerald E. Digital Technology. Chicago, IL: Science Research Associates, Inc.

Williams, Gerald E. Digital Technology, Lab manual. Chicago, IL: Science Research Associates, Inc.

DIGITAL COMMUNICATIONS

COURSE DESCRIPTION

This course is designed to introduce the student to methods and techniques employed to transmit digitized information over various types of transmission systems. Included will be an analysis of: bandwidth considerations, various modulation and detection methods, and coding systems.

PREREQUISITE:

CREDIT HOURS: 4-3-5

COURSE OUTLINE

		Student Contact Hours	
		Class	Laboratory
I.	Introduction to Communication Systems	4	3
II.	The Telephone Network	4	3
III.	System Performance Requirements and Impairment	4	3
IV.	Transmission of Data over Analog System	4	3
V.	Analog Pulse Modulation	4	3
VI.	Digital Modulation	4	3
VII.	Noise and Distortion of Digital Tranmission	4	3
VIII.	Pulse Transmission over Bandlimited Systems	4	3
IX.	Coding Systems	4	3
X.	Network Protocol	4	3

STUDENT LABORATORIES

- Baseband codes, and corresponding encoders and decoders.
- Multilevel baseband data codes, and typical encoders and decoders.
- Clock recovery circuits used in digital data transmissions
- Biternary code and typical encoders and decoders.
- Duo-binary system, and typical encoders and decoders.
- Measure the characteristics of an ASK modulator.

- Observe the characteristics and implementation of an ASK receiver.
- Measure the performance of ASk transmission in white noise.
- Operation of ASk transmission with biternary coding.
- Compare performance measurements of biternary ASk system with binary system.
- Familiarization with PSK waveforms and operation of PSK modulator.
- Operation of carrier recovery circuit and coherent binary PSK detector.
- PSK receiver characteristics.
- Performance of the binary coherent detection PSK system in white noise.
- Measure the performance of the coherent binary DPSK in white noise.
- FSK modulator and waveforms.
- Performance of the binary FSK system in white noise.
- Biternary FSK system in white noise.

STUDENT COMPETENCIES

At the conlcusion of this course, the student will be able to:

- Explain and/or demonstrate principles and implementation of the following:

a. Various baseband codes, and the corresponding encoders and decoders.
b. Clock-recovery circuits for use in digital data transmission.
c. Partial response principles and biternary coding.
d. Performing of the duo-binary system, and typical encoder and decoder circuits.
e. ASK
f. PSK

RECOMMENDED TEXTS

Chau, Computer Communication: Volumne I, Principles, Engewood Cliffs, NJ, Prentice-Hall, Inc. 1982.

Roden, Digital and Data Communication, Englewood Cliffs, NJ, Prentice-Hall, Inc., 1982.

Sinnema, William, Digital, Analog, and Data Communication, Reston Publishing Co,

Theory and Modern Practice of Digital Communication, Degem Systems Ltd.

Baseband Data Transmission DIGICOM-1, Degem Systems,Ltd.

ELECTRONIC DEVICES

COURSE DESCRIPTION

This course is designed to provide the student with a working knowledge of electronic devices. This course will also develop the student's ability to connect and test basic discrete solid-state components as well as basic vacuum tube circuits. Topics include vacuum tube diode and triode, bipolar junction transistors, and other devices and integrated circuits.

PREREQUISITE: Fundamentals to Electricity and Electronics

CO-REQUISITE: Circuit Analysis

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Vacuum Tube Diode and Triode	4	3
A. Introduction to active devices		
B. Physical characteristic		
C. CRT operation		
D. Triode characteristics		
E. Load resistance		
F. Gain		
G. Phase relationships		
H. Basic vacuum tube amplifiers		
II. Semiconductor Diodes	6	6
A. Atomic theory for semiconductors		
B. Silicon, germanium, and PN junctions		
C. Diode applications		
III. Zener Diodes and Other Two-Terminal Devices	8	6
A. Zeners - basic circuits		
B. Schottsky diodes		
C. Varactors (varicaps)		
D. Photodiode		
E. Light-emitting diodes (LEDs) and IR emitters		
F. Liquid crystal diodes		
G. Solar cells		

	Student Contact Hours	
	Class	Laboratory
H. Thermistors		
I. Industrial devices		
IV. Bipolar Junction Transistors (BJT) and Other Active Devices	14	9
A. PNP and NPN atomic characteristics		
B. PJT operation		
C. Amplifying action		
D. Amplifier configurations; common base (CB), common emitters (CE), common collector (CC)		
E. Specification sheets		
F. JFET and MOSFET characteristics		
G. FET operation		
H. Amplifying action		
I. Amplifier configurations		
J. Specification sheets		
V. Integrated Circuits		
A. Types of ICs		
B. Application of ICs		
C. Construction of ICs		

STUDENT LABORATORIES

- Construct and test a common cathode amplifier.
- Design, build, and test a clipper and clamper circuit.
- Design, build, and test a half-wave rectifier and full-wave rectifier circuit.
- Design, build, and test a half-wave filtered power supply.
- Design, build, and test a full-wave filtered power supply.
- Construct and test the common base, common emitter, and common collector amplifier.
- Obtain characteristics of the triac, diac, SCR, and zener using the curve tracer.
- Determine output voltage of the solar cell under different load conditions.
- Construct and test common gate, common source, and common drain amplifiers.
- Identify pin configuration, package type, and characteristics of the integrated circuit using the specifications sheet.

- Construct and determine the AC characteristics of a common base amplifier.
- Construct and determine the AC characteristics of a common collector amplifier.
- Construct and determine the AC characteristics of a emitter amplifier.
- Design a small signal FET amplifier.
- Obtain characteristics of an FET using a curve tracer.
- Determine the high-frequency response of an FET amplifier.
- Build and determine characteristics of a two stage RC-coupled cascade amplifier.
- Build and determine characteristics of a two stage DC-coupled cascade amplifier.
- Determine the characteristics of an FET amplifier.
- Determine the characteristics of a Push-Pull amplifier.
- Determine the characteristics of a complimentary amplifier.
- Determine the characteristics of a differential amplifier.

STUDENT COMPETENCIES

Upon completion of this course the student will be able to:

- Calculate and measure operating Q points of a common base amplifier, and the currents of the device.
- Calculate and measure the Q operating points of a common emitter amplifier and the currents of the device.
- Calculate and measure the Q operating points of a common collector amplifier and the currents of the device.
- Calculate DC parameters of depletion MOSFET circuits.
- Calculate DC parameters of enhancement MOSFET circuits.
- Calculate and measure the following parameters of a common base amplifier: Ae, Ai, Ap, ie, ic, re; ri and phase relation from input to output.
- Calculate and measure the following parameters of a common emitter amplifier as in common base above.
- Calculate and measure the following parameters of a common collector amplifier as in common base above.
- Calcualte all parameters of an FET amplifier.
- Design a small signal FET amplifier.
- Using a curve tracer determine a family of curves for FET.
- Determine the high-frequency response of a FET amplifier.
- Analyze the following parameters in a two-stage cascade amplifier with RC-Coupling: I,E,p in decibel and frequency response.
- Construct and analyze a push-pull amplifier.
- Construct and analyze a complimentary amplifier.
- Construct and analyze a differential amplifier.

RECOMMENDED TEXT

Boylestad, Robert, and Nechelsky, Louis. Electronic Devices and Circuit Theory. Englewood Cliffs, NJ: Prentice-Hall.

ELECTROMECHANICAL DEVICES

COURSE DESCRIPTION

Electromechanical Devices is designed to provide the student with a working knowledge of control elements in electrical circuits, transformers, generators, motors, and synchromechanisms. Topics presented include power losses in transformers, large alternators, DC motor controls and efficiency, three-phase AC motors, synchronous motors, single and three-phase induction motors, stepper motors, and classifications and applications of synchromechanisms.

PREREQUSIITE: Circuit Analysis

CO-REQUISITE: None

CREDIT HOURS: 4-3-5

COURSE OUTLINE

		Student Contact Hours	
		Class	Laboratory
I.	Electromechanical Devices An Introduction A. Magnetic forces and fields B. The origin of magnetism C. Magnetic fields of electric currents D. Forces of charged particles moving through magnetic fields E. Generator action F. Motor action G. Transformers	2	
II.	Control Elements in Electrical Circuits A. Switches B. Testing and maintenance of switches C. Relays D. Testing and maintenance of relays E. Relay circuits F. Fuses G. Checking and replacing fuses H. Checking circuit breakers	4	3
III.	Transformers A. The basic transformer B. Power losses in transformers C. Power transformers D. Auto transformers E. Other transformers F. Troubleshooting transformers	4	3

	Student Contact Hours	
	Class	Laboratory
IV. Generators and Alternators	4	3
A. The simple DC generator		
B. Construction of DC generators		
C. Field coil connections in DC generators		
D. Operation of DC generators		
E. The alternator		
F. Automobile alternators		
G. Large alternators		
H. Operation of alternators		
I. Maintenance		
V. DC Motors and Controls	8	6
A. The simple DC motor		
B. Construction of DC motors		
C. DC motor controls		
D. Motor efficiency		
E. Motor maintenance and troubleshooting		
VI. AC Motors and Controls	10	9
A. Three-phase AC motors		
1. rotating magnetic fields		
2. synchronous motors		
3. induction motors		
4. power factor in AC motors		
B. Synchronous motors		
1. rotor construction		
2. field excitation and power factor		
3. starting synchronous motors		
4. applications of synchronous motors		
C. Three-phase induction motors		
1. rotor construction		
2. starting three-phase induction motors		
3. applications of three-phase induction motors.		
4. wound rotor motors		
D. Single-phase induction motors		
1. capacitor - start motors		
2. permanent-capacitor motors		
3. repulsion-induction motors		
4. shaded-pole motors		
5. speed control of single-phase induction motors		
E. Universal motors		
VII. Stepper Motors	4	3
A. Operation of the stepper motor		
B. Stepper motor control		

	Student Contact Hours Class	 Laboratory
VIII. Synchromechanisms	4	3

- A. The synchro transmitter
- B. The synchro receiver
- C. Differential synchro transmitter and receivers
- D. The synchro control transformer
- E. Classification of synchromechanisms
- F. Applications of synchromechanisms

STUDENT LABORATORIES

- Examine the characteristics and diagram the magnetic fields of permanent magnets and electromagnets.
- Construct common control circuits using switches and relays.
- Construct circuits and measure efficiency of a power transformer.
- Set-up a generator and an alternator and measure the output characteristics.
- Construct a motor circuit and measure the output characteristics of a shunt motor.
- Set up, operate, and determine the functioning characteristics of synchronous, induction, and universal motors.

STUDENT COMPETENCIES

. At the conclusion of this course, the student will be able to:

- Diagram and explain the components and relationships of basic magnetic and electromagnetic systems.
- Use the right hand rule to determine direction of force on a conductor or a current carrying a conductor in a magnetic field.
- Identify, diagram, and explain the functioning characteristics of basic types of relays used in electrical circuits.
- Identify, diagram and explain the function of basic fuses.
- Construct a relay control circuit.
- Diagram, label, and explain the functioning characteristics and the components of basic types of transformers.
- Determine primary voltage and current, secondary voltage and current, input power and efficiency of a transformer.
- Test transformers for continuity of windings, and shunted windings.
- Diagram, label, and explain the functioing characteristics of basic generators.

- Operate a DC generator and alternator and determine their operating characteristics.
- Diagram, label, and explain the components and functioning characteristics of common types of DC Motors.
- Specify appropriate types of motors for a given mechanical load.
- Diagram, label, and explain the components and functioning characteristics of common AC motors.
- Construct, test, and plot the curve of a DC motor circuit.
- Diagram, label, and explain the components and functioning characteristics of common types of AC motors.
- Given necessary data , determine the number of magnetic poles, synchronous speed, operating speed, slip speed of common AC Motors.
- Operate properly universal motor, shaded pole motor, capacitor start motor.

RECOMMENDED TEXTS

Center for Occupational Research and Development. Electromechanical Devices. Waco, TX: CORD, 1981.

Alevich, Walker N. Electric Motor Control. New York: Van Nostrand Publishing Co., 1975.

Anderson, Edwin P. Electric Motors. Indianapolis, IN: Theodore Aide and Co., 1969.

Fitzgerald, A.E. and Kirply, Charles, Jr. Electric Machinery. New York: McGraw-Hill Book Co., Inc. 1952.

ENGINEERING GRAPHICS I

COURSE DESCRIPTION

An introductory course to provide the technician with basic skills and techniques used to communicate information and ideas graphically. Topics to include: an introduction to freehand sketching; graphic drafting techniques and procedures, schematic drawing; descriptive geometry; and computer graphics.

PREREQISITE: Algebra

CO-REQUISITE: Trigonometry

CREDIT HOURS: 1-6-3

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. Technical Sketching	1	9
A. Sketching lines, circles, and arcs		
B. Using the box construction technique		
C. Sketching in isometric		
D. Sketching in oblique		
II. Drafting Fundamentals	2	15
A. Use of instruments		
B. Lettering		
C. Alphabet of lines		
D. Drawing reproduction		
E. Scale		
F. Dimensioning and tolerancing		
G. Geometric construction techniques		
III. Orthographic Projection	2	15
A. Third-angle projection in drawing		
B. Section drawing		
IV. Pictorial Drawing	2	12
A. Drawing objects in isometric		
V. Schematic Drawing	1	6
VI. Descriptive Geometry	2	12
A. True length, slope, and bearing		
B. Auxiliary views		
C. Developments		

	Student Contact Hours Class	 Laboratory
VII. Computer Graphics	1	
A. Drawing on CRT		
B. CAD introduction		
VIII. Overview of Engineering Graphics Drawing in Industry	1	

STUDENT LABORATORIES

- Make freehand sketches in isometric and oblique.
- Use drafting instruments to make simple drawings involving geometric construcion techniques.
- Make drawings of objects in orthographic.
- Make isometric drawings of simple objects.
- Make schematic drawings.
- Find true length, slope, and bearing of lines.
- Make developments of objects.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Make simple freehand sketches that will describe an object or a process in three dimensions.
- Use drafting instruments to make simple engineering drawings.
- Draw and interpret objects in orthographic projection.
- Draw and interpret simple objects in isometric.
- Prepare and interpret schematic drawings.
- Graphically find the true length, slope, and bearing of a line.
- Determine true shapes and sizes of surfaces from alternative vies utilizing the line and plan methods of descriptive geometry.
- Discuss the use of computer as a graphics tool.

RECOMMENDED TEXT

Luadder, Warren J., Fundamentals of Engineering Drawing. Englewood Cliff, N.J.: Prentice-Hall, 1981.

ELT PROBLEMS

COURSE DESCRIPTION

The electronic engineering technology courses embrace such a wide base of knowledge and specialty options; and, additioanlly, laboratories available vary widely as do the materials available to stduents for projects; therefore, the problems course presented here represents only general guideline.

PREREQUISITE: Consent of Instructor

CREDIT HOURS: 0-9-3

COURSE OUTLINE

- I. Define Scope and Rules for Projects
  - A. Instructos(s) give parameters
    - 1. time (1 quarter)
    - 2. cost
    - 3. effectiveness
  - B. Student submits proposal
    - 1. preliminary sketcher/diagrams
    - 2. performance parameters
    - 3. time needed to design and build
    - 4. test procedures & validation
    - 5. cost
  - C. Instructor(s) evaluate and assign projects
    - 1. individual projects
    - 2. group projects
    - 3. develops performance contract
      - a. time required/phase
      - b. progress reports
      - c. grading parameters
    - 4. assigns suitable individual proposal writers to work with others.
- II. Implement Projects
  - A. Design phase
    - 1. student undertakes design
    - 2. student makes progress review against objectives
    - 3. instructor evaluates, advises and approves build
  - B. Build phase
    - 1. student undertakes construction
    - 2. student makes progress review against

        objectives
    3. instructor evaluates, advises and grades
- C. Test
    1. student devises test and conducts it
    2. student writes test report and/or failure analysis
    3. instructor evaluates and grades
- D. Engineering Report
    1. student prepares comprehansive engineering report
    2. instructor evaluates and grades

STUDENT LABORATORIES

- Prepare sketches and diagrams for submittal to instructor.
- Complete design for instructor approval and grading.
- Build, as appropriate, the project designed.
- Devise and conduct engineering tests on the project.
- Compile a comprehensive engineering report on the subject.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Define a technical problem and design a workable solution.
- Design, construct, test, evaluate and modify a functional device/circuitry/system utililing/electrical, mechanical and/or electronic component.

LINEAR INTEGRATED CIRCUITS

COURSE DESCRIPTION

This course includes topics necessary to give the student an understanding of linear integrated circuits and their applications. Emphasis is placed on the operational amplifier. The student will be introduced to other state-of-the-art devices.

PREREQUISITE: Semi-Conductor Analysis

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Introduction to the Op Amp	3	3
A. Diff. Amp. Review		
B. Ideal Op-Amp		
C. Real Op-Amp		
D. Op-Amp Terminals		
E. Op-Amp Characteristics		
F. Types of Op-Amps		
II. Inverting and Non-Inverting Amplifiers	5	6
A. The inverting amplifier		
B. Inverting adder		
C. Inverting averaging amplifier		
D. Voltage follower		
E. Noninverting amplifier		
F. Noninverting adder		
G. Integrator		
H. Differentiator		
III. Comparators	5	3
A. Effect of noise on comparator circuit		
B. Positive feedback		
C. Voltage-level detectors with hysteresis		
IV. Bias, Offsets and Drift	5	3
A. Input bias currents		
B. Input offset currents		
C. Effect of offset current on output voltage		
D. Effect of bias currents on output voltage		

	Student Contact Hours	
	Class	Laboratory
E. Input offset voltage		
F. Nulling-out effect of offset voltage and bias current		
G. Drift		
V. Bandwidth, Slew Rate, Noise and Frequency Compensation	5	5
A. Frequency response of the Op AMP		
B. Slew rate and output voltage		
C. Noise in the output voltage		
D. External frequecy compensation		
VI. Active Filters	7	6
A. Low-pass filter		
B. Introduction to the Butterworth filters		
C. Low-pass Butterworth filters		
D. High-pass Butterworth filters		
E. Band-pass filters		
F. Notch filters		
VII. Power Supplies	6	3
A. Introduction to unregulated and regulated power supplies		
B. Positive 3-terminal regulators		
C. Negative 3-terminal regulators		
D. Dual tracking voltage regulator		
VIII. Signal Generators	4	3
A. Operating modes of the 555 times		
B. Applications of the 555 times		
C. Free-running and one shot operation		

STUDENT LABORATORIES

- Contruct the open-loop amplifier.
- Construct the closed-loop amplifier and monitor and analyze offset parpmeters.
- Design voltage-level detectors and comparators.
- Design low-pass and high-pass active-filter circuit.
- Construct and analyze regulated power supply.
- Design an adder and averaging circuit.
- Construct and analyze a comparator circuit.
- Design a timer circuit.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Construct and analyze the open and closed loop operation of the Op Amp.
- Breadboard on Op Amp using a single power supply.
- Analyze voltage level detectors and comparators.
- Explain the application of the Op Amp in wave shaping (i.e.: Signal Generation)
- Construct and analyze a differential amplifier circuit.
- Identify and explain:
    a. Bias
    b. Offset Voltage
    c. Drift
    d. Band width
    e. Slew rate
    f. Noise
    g. Frequency compensation

- Construct and analyze an analog multiplier circuit.
- Design a low-pass and high-pass active-filter circuit.
- Breadboard a timer circuit using a 555 timer.
- Construct a regulated power supply using a three terminal regulator.

RECOMMENDED TEXT

Coughlin, Robert F. and Driscoll, Fredrick F. Operational Amplifier and Linear Integrated Circuitry. Second Edition, Prentice-Hall, Inc.

MICROCOMPUTER APPLICATIONS I

COURSE DESCRIPTION

This course is a continuation of digital applications and is designed to emphasize the interfacing of the microcomputer with peripherals.

PREREQUISITE: Digital Applications

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Mathematical Refinement	4	6
A. Multiple-precision numbers		
B. Multiplication		
C. Positive and Negative numbers		
D. BCD Addition		
II. Basic I/O and Interfacing Techniques	8	9
A. Synchronous vs asynchronous		
B. Handshaking		
C. Programmed I/O vs interrupt I/O		
D. DMA I/O		
E. Memory-mapped I/O vs isolated I/O		
F. Keyboard input		
G. Display mutiplexing		
H. Video display		
I. Data acquisition		
III. Programmable Peripheral Chips	8	3
A. Basics of programmable peripheral chips		
B. PIO		
C. Serial-parallel		
IV. Data Communication	8	6
A. Synchoronous vs asynchronous		
B. Simplex/suplex transmission		
C. Transmission codes		
D. RS-232C		
V. Controllers	12	6
A. Single-chip microcontrollers		
B. Stepper motor		
C. Stepper motor interface		

STUDENT LABORATORIES

- Write a program to handle positive and negative numbers.
- Write a program to solve problems in BCD.
- Write a program to select an address register and transfer data from the CPU to the peripheral interface bus.
- Write a program to set up the PIA as an input and output device.
- Construct a circuit using a UART for serial to parallel or parallel to serial data handling.
- Construct an interface circuit consisting of Opto-Isolators.
- Connect a microcomputer to a peripheral through a UART interfacing using a 20ma loop.
- Connect a microcomputer to a peripheral through a Y4UART interfacing using a RS-232C line.
- Connect a microcomputer to a stepper motor.
- Write a program to exercise a stepper motor.
- Construct A/D and D/A converters.
- Write a program for successive approximation using converters.

STUDENT COMPETENCIES

- Convert between decimal, binary, and hex number systems.
- Write programs to solve arithmetic problems.
- Demonstrate the use of I/O ports.
- Program the PIA control registers and use the control lines as input and output.
- Explain the input and output circuits used in current loops by means of a schematic diagram.
- Explain who opto-isolators are required in current loops used with microprocessors.
- List the basic capabilities of the RS-232C interface.
- Use a circuit diagram to explain how RS-232C signals can be converted to TTl or 20ma current loop.
- Develop methods of controlling a stepper motor with a microcomputer.
- Demonstrate how a A/D converter can be used with a microcomputer.
- Demonstrate how a D/A converter can be used with a microcomputer.

RECOMMENDED TEXT

The Intelligent Microcomputer, Roy W. Goody, Science Research Associates, Inc.

MICROCOMPUTER APPLICATIONS II

COURSE DESCRIPTION

This course is a continuation of Microcomputer Applications I. Emphasis is placed on the microcomputer as a controller.

PREREQUISITE: Microcomputer Applications I

CREDIT HOURS: 4-3-5

COURSE OUTLINE

	Student Contact Hours	
	Class	Laboratory
I. The Microcomputer As A Controller A. Microcomputer interfacing B. Closed-loop control systems	8	6
II. Microcomputer Troubleshooting A. The signature analysis approach B. The logic analyzer	8	6
III. Comparison of 8 bit Microcomputers A. Z-80 based microcomputers B. 6502 based microcomputers C. 8080 based microcomputers D. 6800 based microcomputers	8	6
IV. The 16 Bit Microcomputer A. Comparison of the 16 bit and 8 bit microcomputer B. 16 Bit software C. 16 bit I/Os D. 16 bit interfacing	16	12

STUDENT LABORATORIES

- Construct a circuit that used optical tranducers and micro to simulate a security system.
- Construct a circuit using a micro and transducers to count revolutions of a mechanical device.
- Given a microcomputer, use a logic analyzer and logic probe to demonstrate troubleshooting techniques.
- Demonstrate the operation of a 16 bit microcomputer.

STUDENT COMPETENCIES

- Design the interface used between a microcomputer and a given device.
- List the steps in logic troubleshooting of a microcomputer.
- Discuss the modes of operation for a logic-analyzer/signature analyst.
- Give examples of the proper use of logic probes and pulser.
- List the different characteristics of at least two different CPUs.
- List the major differences between 16 bit micros and 8 bit micros.

RECOMMENDED TEXT

Z-80 Microcomputer Design Projects. William Baaden, Jr. , Howard W. Sams & Company, Inc.

SATELLITE AND TELECOMMUNICATIONS

COURSE DESCRIPTION

This course is designed to introduce the student to satellite and telecommunications systems, fiber-optic systems, and lasers.

PREREQUISITE: Antennas, Transmission Lines, and Microwaves

CO-REQUISITE: Communications Problems

CREDIT HOURS: 4-3-5

COURSE OUTLINE	Student Contact Hours	
	Class	Laboratory
I. Digital Communications	10	9
A. Pulse - amplitude modulation		
B. Pulse - width modulation		
C. Pulse - position modulation		
D. Pulse - code modulation		
E. Time - division multiplexing		
F. Delta modulation		
G. Frequency shift keying		
H. Code transmission		
II. Fiber-Optic Systems	10	9
A. Introduction to Opto-electronics		
B. Safety		
C. Light transmission		
D. Light reception		
E. Optical components		
F. Optical fibers, cables, and couplings		
G. Fiber-optic systems		
III. Lasers	10	6
A. Laser classifications		
B. Solid-crystal laser		
C. Gas lasers		
D. Liquid lasers		
E. Safety		
F. Modulating techniques		
IV. Satellite Communications	10	6
A. Introduction to communication satellites		

B. Director broadcast satellites
C. Advantages of digital over analog satellite communications
D. Satellite orbital positions
E. Transmitting and receiving antennas
F. Up-links and down-links
G. Noise
H. LNA's. LNC's and down converters
I. Link performance

STUDENT LABORATORIES

- Design a pulse-width modulator.
- Observe the operation of an FSK modulator and demodulator.
- Construct a pulse width demodulator amd observe its operation.
- Demonstrate the principles of light modulation.
- Construct a fiber-obtic system and observe its operation.
- Monitor a fiber-optics output while bending the fiber.
- Set up a laser transmitter with and without modulation.
- Align a satellite receiving antenna to a given satellite.
- Observe the operation of a direct-feed satellite receiving antenna.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Design a pulse-width modulator.
- Explain the principles of pulse-amplitude, pulse-width, pulse position, and pulse-code modulation.
- Explain the principles of light transmission and reception.
- Explain the operation principles of optical fibers, cables, and couplers.
- Demonstrate the operation of a fiber-optic system.
- Demonstrate the operation of a laser.
- Compare the various types of lasers.
- Determine the earth station antenna's position for each satellite.
- Explain the effect of noise on link performance.
- Explain the operation of LNA's, LNC's, and down converter as part of a link system.

RECOMMENDED TEXTS

Feher, Dr. Kamile, Digital Communications, First Edition. Prentice-Hall

Miller, Gary M. Modern Electronic Communication, Second Edition, Prentice-Hall.

Seippel, Robert G., Optoelectronics, First Edition, Reston Publishing Company.

SEMICONDUCTOR ANALYSIS

COURSE DESCRIPTION

This courses is designed to provide the student with a knowledge of BJT and FET amplifiers. H-parameter equivalent circuits, frequency response, and design considerations are emphasized in this course.

PREREQUISITE: Electronic Devices, Circuit Analysis

CO-REQUISITE:

CREDIT HOURS: 3-3-4

COURSE OUTLINE

		Student Contact Hours	
		Class	Laboratory
I.	DC Biasing of BJTs	6	4
	A. Operating point		
	B. Common-base circuit		
	C. Common-emitter circuit		
	D. Bias stabilization		
	E. BETA dependent biasing		
	F. BETA independent biasing		
	G. DC bias with voltage feedback		
	H. Common collector circuit		
	I. Design of DC bias circuits		
II.	FET Biasing	3	4
	A. Fixed bias		
	B. JFET amplifier		
	C. Depletion MOSFET DC bias circuits		
	D. Enhancement MOSFET bias circuits		
III.	BJT Small-Signal Analysis	3	4
	A. Transistor hybrid equivalent circuits		
	B. H-parameter		
	C. Small-signal analysis using h-parameters		
	D. Approximations of hybrid equivalent circuits		
IV.	FET Small-Signal Analysis	6	4
	A. JFET/depletion MOSFET small signal		
	B. AC small-signal operation		

	Student Contact Hours	
	Class	Laboratory
C. Source follower circuits		
D. Design of FET amplifier circuits		
E. High-frequency effects		
V. Multistage Systems and Frequency Consideration	6	4
A. General cascaded systems		
B. RC-coupled amplifiers		
C. Transformer-coupled amplifiers		
D. D.C. coupled amplifiers		
E. Cascade amplifier		
F. Decibels		
G. General frequency considerations		
H. Low-frequency considerations		
I. High-frequency considerations		
J. Multistage frequency effects		
K. Frequency response of cascaded FET amplifiers		
VI. Large-Signal Amplifiers	3	6
A. Series-fed class-A amplifiers		
B. Transformer-coupled audio power amplifier		
C. Classes of amplifier operation and distortion		
D. Push-pull amplifier circuit		
E. Heat sinking		
VII. The Differential Amplifier	3	4
A. DC biasing		
B. Single-ended input and output		
C. Common-mode input		
D. Differential voltage gain		

STUDENT LABORATORIES

- Construct and determine DC characteristics of a common base amplifier.
- Construct and determine DC characteristics of a common collector amplifier.
- Construct and determine DC characteristics of a common emitter beta-dependent circuit.
- Determine biasing characteristics of FET amplifier.
- Determine characteristics of Depletion Mode MOSFET.
- Determine characteristics of Enhancement Mode MOSFET.

- Construct and determine the AC characteristics of a common base amplifier.
- Construct and determine the AC characteristics of a common collector amplifier.
- Construct and determine the AC characteristics of a emitter amplifier.
- Design a small signal FET amplifier.
- Obtain characteristics of an FET using a curve tracer.
- Determine the high-frequency response of an FET amplifier.
- Build and determine characteristics of a two stage RC-coupled cascade amplifier.
- Build and determine characteristics of a two stage DC-coupled cascade amplifier.
- Determine the characteristics of an FET amplifier.
- Determine the characteristics of a Push-Pull amplifier.
- Determine the characteristics of a complimentary amplifier.
- Determine the characteristics of a differential amplifier.

STUDENT COMPETENCIES

Upon completion of this course the student will be able to:

- Calculate and measure operating Q points of a common base amplifier, and the currents of the device.
- Calculate and measure the Q operating points of a common emitter amplifier and the currents of the device.
- Calculate and measure the Q operating points of a common collector amplifier and the currents of the device.
- Calculate DC parameters of depletion MOSFET circuits.
- Calculate DC parameters of enhancement MOSFET circuits.
- Calculate and measure the following parameters of a common base amplifier: Ae, Ai, Ap, ie, ic, re; ri and phase relation from input to output.
- Calculate and measure the following parameters of a common emitter amplifier as in common base above.
- Calculate and measure the following parameters of a common collector amplifier as in common base above.
- Calcualte all parameters of an FET amplifier.
- Design a small signal FET amplifier.
- Using a curve tracer determine a family of curves for FET.
- Determine the high-frequency response of a FET amplifier.
- Analyze the following parameters in a two-stage cascade amplifier with RC-Coupling: I,E,p in decibel and frequency response.
- Construct and analyze a push-pull amplifier.
- Construct and analyze a complimentary amplifier.
- Construct and analyze a differential amplifier.

STUDENT COMPETENCIES

At the conclusion of this course, the student will be able to:

- Construct and analyze the open and closed loop operation of the Op Amp.
- Breadboard on Op Amp using a single power supply.
- Analyze voltage level detectors and comparators.
- Explain the application of the Op Amp in wave shaping (i.e.: Signal Generation)
- Construct and analyze a differential amplifier circuit.
- Identify and explain:
    - a. Bias
    - b. Offset Voltage
    - c. Drift
    - d. Band width
    - e. Slew rate
    - f. Noise
    - g. Frequency compensation
- Construct and analyze an analog multiplier circuit.
- Design a low-pass and high-pass active-filter circuit.
- Breadboard a timer circuit using a 555 timer.
- Construct a regulated power supply using a three terminal regulator.

RECOMMENDED TEXT

Coughlin, Robert F. and Driscoll, Fredrick F. Operational Amplifier and Linear Integrated Circuitry. Second Edition, Prentice-Hall, Inc.

PILOT LEVEL TEACHING EQUIPMENT INFORMATION FOR ELECTRONICS TECHNOLOGY

Note: This is a suggested equipment list which is considered to be a minimum requirement for carrying out pilot level programs.

ELECTRONICS ENGINEERING TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Electronics Fundamentals & Passive Components

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Basic Electronics Trainer and Accessories	10	$325	$3,250
Combination Hi/Lo DC/AC Power Supply		10	445	4,450
Function Generator		10	200	2,000
VOM		10	150	1.500
Digital Multimeter		10	650	6,500
Student Quality Oscilloscope		10	700	7,000
Resistance Decade		5	100	500
Capacitor Sub. Box		5	50	250
Isolation Transformer		10	125	1,250
				$26,700

ELECTRONICS ENGINEERING TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Basic Circuits & Active Devices

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Electronics Circuit Trainer Accessories	7	$220	$1,540
Tri-Low-Voltage Power Supply		7	200	1,400
Signal Generator		7	500	3,500
Curve Tracer		1	7,700	7,700
Transistor Tester		1	240	240
Tube Tester		1	550	550
RCL (Impedance) Bridge		1	500	500
				$15,430

ELECTRONICS ENGINEERING TECHNOLOGY PROGRAMS - SUGGESTED EQUIPMENT INFORMATION

Integrated Circuits, Digital and Microprocessor Fundamentals

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
	Integrated Circuit Trainer and Accessories	10	$ 400	$ 4,000
	Digital Techniques Trainer and Accessories	10	255	2,550
	Microprocessor Trainer and Accessories	10	425	4,250
Test Lab Quality Dual-Trace Oscilloscope with Delayed Sweep and Storage		1	6,860	6,860
Industrial Quality Dual-Trace Oscilloscope		10	2,000	20,000
Scope Probes		20	60	1,200
Data Analyzer, with options		1	4,000	4,000
Logic Probe (TTL, CMOS)		3	125	375
Logic Probe (ECL)		1	200	200
Logic Pulser		2	195	390
Logic Clip		3	165	495
Current Tracer		1	375	375
Logic Comparator with Ref. Brd.		1	625	625
	D/A & A/D Devices	1	4,000	4,000
	Transducer Systems	1	4,000	4,000
	Miscellaneous Interfacing Devices and Components	1	4,000	4,000
				$57,320

ELECTRONICS ENGINEERING TECHNOLOGY

Advanced Courses

Equipment/ Instrumentation	Training Devices/ Systems	Qty. Per School	Approximate Unit Cost	Extension
Spectrum Analyzer		1	$27,500	$27,500
Earth Satellite Receiving System		1	10,000	10,000
	Fiber Optics Training Units	5	4,000	20,000
Communications Systems (Feedback)		5	6,000	30,000
	Synchro-Servo Training System	5	5,000	25,000
Oscilloscope with Options - High Resolution		6	7,685	46,110
Oscilloscope with Options - High Resolution/High Stability		2	12,225	24,450
Logic Analyzer with Options		1	6,700	6,700
Logic Analyzer with Options - High Resolution		1	10,600	10,600
System Controller with Options		1	7,000	7,000
Digital Counters		5	1,600	8,000
Digital Multimeter - Programmable		1	1,995	1,995
Universal Digital Counter/Timer - Programmable		1	3,875	3,875
Power Supply - Programmable		1	2,500	2,500
Oscilloscope - Dual Trace Storage		1	11,900	11,900
Read Only Memory (ROM) Programming System		1	25,000	25,000
				$260,630

APPENDIX A

SUGGESTIONS FOR IMPLEMENTING A PROBLEMS COURSE

SUGGESTIONS FOR IMPLEMENTING A PROBLEMS COURSE

I. INTRODUCTION

The problems course is intended to be the capstone of the two years a student spends in the technical school. It should be problem/project centered and attempt to synthesize everything that has occurred throughout the curriculum. It is also possible to broaden the student's areas of understanding during this time and to cover topics not covered because of time or other constraints. An excellent strategy is to pair students from different disciplines, EMT/EET, Robotics/CAD etc., just as might happen in industry. A great deal of learning and sharing can take place through this arrangement and the experiences should as closely as possible approximate the conditions of the "real" high tech world.

II. POSSIBLE PROBLEMS TO BE ENCOUNTERED

Too often, curriculum designers suggest problems courses which sound ideal on paper, but are impossible to implement. This is due, in the final analysis, to widely uppredictable factors discovered at the time the problems course is to come togeher, such as:

A. Student numbers and distribution

The M.E./E.M.T. combination, for example, could arrive at the proper quarter for "problems" without a design student or a production student. What then?

Obviously, adjustments would need to be made. If a mechanical design student were lacking, then a on-design project should be picked - - such as replication an electromechanical device (which would increase the number of devices available for future learning labs.).

Invaluable experience would be gained in measuring the parts to be replicated, then describing them accurately on CAD. If a production student were then available, he/she could translate the CAD data into CAM operations to make the parts. In the absence of a production student, a machine student could complete the CAM cycle.

Finally, the electromechanical technology students could assemble and check out the product. If no electromechanical technology students were available, it is conceivable that the mechanical technology students could complete the project in cooperation with the electronic/electric technology students.

Chances are good that, in combining classes, numbers will seem too large and unmanageable for a single, coordinated project. In this case there are reasonable options:

1. Assign small individual projects concurrently with a coordinated, or group project.
2. Assign a group project large enough so that all students can work on a sub-assembly or detail part of the whole. (Beware of a "log jam" at test and checkout!)
3. Assign two or more group projects.

The above examples of "what-ifs" are intented to serve as a model to stimulate thinking of ways to solve number and distribution problems.

B. Student progress and distribution

Occasionally students arrive at the "problems" area somewhat weak in an area of knowledge. Seldom is distribution of this weakness such that all students have the subject deficiency. In the case of a reasonable number having a well-rounded grasp of the technology, "pairing" of the lesser skilled students with the stronger students can be beneficial.

In a case where the distribution runs to a majority weakness in an area of knowledge, the curriculum should be examined. However, to proceed with the subject group, the staff should steer the projects in such a way that they tend to remediate the lack.

C. Student creativity

It is desirable to draw first from the ideas of the student body in putting together "problems" projects. Often it is possible to assign small projects that were originated individually by the students themselves. Or, students may suggest a coordinated, or group, project that is very worthy. It is an excellent idea to work closely with local firms having tool design needs. Simple tools and equipment can be designed and built for these companies (to the great benefit of both parties). Occasionally, however, solicitation of proposals for projects produces a low number of useable ideas. It is wise to have on hand a number of both individual and group projects from which the students may choose to their liking.

III. PLANNING A PROBLEMS COURSE

A "problems" course can linger in a student's mind as the high-water mark of technical education, or be remembered as waste of time. The difference usually is in the planning done by the school staff.

A. Interdiscipline staff coordination

If "problems" are to be attempted which simulate an engineering / manufacturing environment, an interdiscipline approach should be taken (such as a problem involving M.E. and E.M.T.). The first step is for the staff in these disciplines to meet and address the following minimum issues.

1. What roles each staff member would assume.
2. What laboratories will be needed.
3. What scope of project (s) is reasonable.
4. Maximum material costs affordable.
5. General learning objectives desired.
6. Estimated number of students per group project.

B. Formulating student entry

Many approaches are possible to enlist and assign students to projects, but the staff should have planned in detail how the student be assigned to a "problems" project.

A suggested method follows:

1. Staff and students need to discuss thoroughly the rules regarding time, cost, scope, and grading.
   Give handouts.
2. Students receive a form for proposal and deadline.
3. Students submit proposals.
4. Instructors evaluate proposals, suggest changes and deadline.
5. Instructors assign individual projects and group projects.

C. Formulate engineering coordination methods

Students sharing a group design/make project across 2 or 3 disciplines will need an organized way to coordinate their design and build efforts.

They need to learn the methods employed by industry

1. Suggest that the groups elect a "project" engineer who will be responsible for total coordination of the project. Elect assistant for backup.

2. Suggest that each discipline elect a "group" engineer;i.e., a single point of contact for that group.
3. Suggest that each "group" engineer assign tasks within his/her group.
4. Establish regular coordination meetings (usually with basically a fixed format to prevent digression).
5. Empower "project" engineer to call special meetings as required.
6. Suggest weekly progress reports by "group" engineer to the "project" and a composite weekly report from the "project" engineer.
7. Suggest that "project", in conjunction with "group", prepare a master schedule and keep it current. Off-schedule reports must be accompanied by "make-up" plans and newly scheduled target dates.
8. Suggest that "group" prepare all the input data as they go to allow revision and prompt compilation of the final engineering and cost report.
9. Suggest that "project" demand as we go data to allow compilation of the final engineering and cost reports in a timely manner (project status, man hours, span time and cost, etc.)
10. Suggest that a file be set up for drawings and that it be handled professionally. Changes should be documented and routed to "group" and "project" leaders.

D. Plan the physical details

Often all the people and procedural plans are in order, but the physical and logistical plans are sketchy. They staff should give considerable thought to the following:

1. Materials. Are there adequate materials for student projects?
Have plans been laid for timely puchases of special needs?

2. Special processes. Some special needs, such as heat-treating, may be generated in the projects. Have plans been laid to handle these needs?

3. Equipment availablity. If the project is large, or if there are multiple projects, access to machines and equipment can become a problem. Considerable thought must be given to availability and scheduling of CAD and CAM

equipment, as well as utilizing non-CAM machines.

4. Space. It is desirable to set up a simulated engineering/produciton setting. Is space available? Can "group" and "project" leaders set up a simulateed office (or work stations with pigeonholes and baskets for report and change notices)?

E. Formulate progress reviews

Obviously the coordinated, or group, project described in c above, will be supplying weekly reports at both group and project levels. They will also maintain a master schedule as well, so progress will be well documented.

It is possible, however, to have a group project going concurrently with small individual projects. The individual should learn the same discipline of reporting that is legislated for the group.

Following is a suggested method:

1. Prepare a "contract" with the student relative to completion of design, build, test and final engineering reports.
2. Discuss the progress reports and format to preclude any misunderstanding. Explain weight of progress reviews in final grade.
3. Follow up! The instructor must call for progress reviews, look at them and return them as quickly as possible.

F. Formulate a grade system

Since student projects have disinct phases it is suggested that some method be designed to grade accoridngly. Additionally, it is sometimes case that a project cannot be completed in the allotted time. If grading is done by phases in these cases, a base exists for formulating a final score.

Phases of a project and grading could be as follows:

1. Organization of the engineering/producion groups.
2. Design of engineering checkoints and controls, including forms and paperwork.
3. How effective group coordinaton actually is.
4. Aptness of the design vs. the oparameters.
5. Producability of the product.

6. How well the design fulfills the original parameters.
7. How well schedules are met
8. The test procedure.

APPENDIX B

TECHNICAL SOCIETIES

TECHNICAL PUBLICATIONS OF INTEREST

TECHNICAL SOCIETIES AND ORGANIATIONS

American Automatic Control Council (AACC)
P.O. Box 12277, Research Triangle Park, NC 27709
919/549-0600

Numerical Control Society (Automatic Control) (NCS)
519 Zenith Drive, Glanview, IL 60025
312/297-5010 Responsibility for the application of numerical control techniques.

Institute of Electrical and Electronics Engineers (IEEE)
345 East 47th Street, New York City, NY 10017
212/644-7910

International Society for Hybrid Microelectronics (ISHM)
P.O. Box 3255, Montgomery, AL 36109 205/272-3191
Ceramics, thick/thin films, semiconductor packaging, discrete semiconductor devices, and monolithic circuits. Bimonthly newsletter.

National Engineering Consortium (NECO (Not an association)
1211 West 22nd Street, Oak Brook, IL 60521 312/325-5700
Provides fellowships, scholarships, grants, and endowments to engineering students for furthering electronic training.

Accreditation Board for Engineering and Technology (ABET)
345 East 47th Street, New York City, NY 10017 312/644-7685
Accredits college engineering curricula and engineering technology programs.

American Association of Engineering Societies (AAES)
345 East 47th Street, New York City, NY 10017
212/686-5676
Advance the science and practice of engineering in the public interest.

American Institute of Industrial Engineers (AIIE)
25 Technology Park, Norcross, GA 30092 404/449-0460
Design, improvement, and installation of integrated systems of people, materials, equipment, and energy.

American Institue of Plant Engineers (AIPE)
3975 Erie Avenue, Cincinnati, OH 45208
Newsletter 8 times/year; journal quarterly.

American Society for Certified Engineering Technicians (ASCET)
4450 West 109th Street, Overland Park, KS 66211 913/341-5669
Skilled technicians whose training and experience qualify them to provide technical support and assistance to registered professional engineers. Certified Engineering Technician, bimonthly.

Automated Procedures and Engineering Consultants (APEC)
Miami Valley Tower, Suite 2100, Dayton, OH 45402
513/228-2602
Application of up-to-date computer technology to building design. Journal, bimonthly.

Engineering Technologist Certification Institute (ETCI)
2029 K Street, NW< Washington, DC 20006 202/659-5773
Not a membership organization. Issues certificates for Associate Technologists and Engineers.

American Institute for Design and Drafting (AIDD)
3119 Prince Road, Bartlesville, OK 74003 918/333-1053
Design and Drafting News, monthly.

Design and Drafting Management Council (DDMC)
P.O. Box 11811, Santa Ana, Ca 92711 714/838-5800
Computer-assisted drafting. Library. Commentary, monthly.

Engineering Reprographic Society (ERS)
P.O. Box 5805, St. Louis, MO 63134 314/232-7386

American Federation of Information Processing Societies (AFIPS)
1825 North Lynn Street, Suite 800, Arlington,VA 22209
703/558-3600
Serves as national voice for the computing field, advanced knowledge of the information processing sciences.

Association for Computing Machinery (ACM)
1133 Avenue of Americas, New York City, NY 10036
212/265-6300

Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME)
Box 930, One SME Drive, Dearborn, MI 48128 313/271-1500

Instrument Society of America (ESA)
P.O. Box 1227, Research Triangle Park, NC 27709
919/549-8411
Instruments and controls in science and industry. Instrumentation Technology, monthly.

Society of Manufacturing Engineers (SME)
P.O. Box 930, Dearbor, MI 48128 313/271-1500
Library. Manufacturing Engineering, monthly.

American Society for Mechanical Engineers (ASME)
345 East 47th Street, New York City, NY 10017 212/644-7722
Sponsor for ANSI. Library. Applied Mechanics Review, monthly. Mechanical Engineering, monthly.

American Institute of Physics (AIP)
335 East 45th Street, New York City, NY 10017
212/661-9404

American Physical Society
335 East 45th Street, New York City, NY 10017
212/682-7341

American Society for Quality Control (ASQC)
161 West Wisconsin Avenue, Milwaukee, WI 53227
414/272-8575
Quality Progress, monthly.

International Institute for Robotics (IIR)
Box 21078, Dallas, TX 75211
Small library. *Robotics Newsletter*, monthly.

Robot Institute of America (RIA)
P.O. Box 930, Dearborn, MI 48128 313/271-1500
Robotics Today, quarterly.

Robotics International (RI/SME)
P.O. Box 930, Dearborn, MI 48128 313/271-1500
Library. Robotics Today, bimonthly.

American National Standards Institute
1430 Broadway, New York City, NY 10018 212/354-3300

JOURNALS AND OTHER PUBLICATIONS OF INTEREST TO THE ENGINEERING TECHNICIAN

American Journal of Physics, monthly $25
335 East 45th Street, New York City, NY 10017

American Machinist, biweekly, $25
1221 Avenue of the Americas. New York City, NY 10020

Canadian Controls and Instrumentation, monthly, $10/12
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Canadian Datasystems, monthly $10/12
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Canadian Electronics Engineering, monthly, $10/12
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Computer, monthly, $30
5855 Naples Marine Plaza, Suite 301, Long Beach, CA 90803

Computer Decisions, monthly, $15
50 Essex Street, Rochelle Park, NJ 07662

Computers and Automation, 13 times/year, $18.50
815 Washington Street, Newtonville, MA 02160

Computerworld, weekly, $12
797 Washington Street, Newtonville, MA 02160

Data Management, monthly, $8
505 Busse Highway, Park Ridge, IL 60068

Datamation, monthly, $18
35 Mason Street, Greenwich, CT 06830

Design Engineering, monthly, $12/15
481 University Avenue, Toronto, Ontario, Canada M52 1A7

Design News, biweekly, $20
221 Columbus Avenue, Boston, MA 02116

EE - Electrical Equipment, monthly, no price listed
172 South Broadway, White Plains, NY 10605
(Instrument Society of America)

Electromechanical Design, monthly, $20
167 Corey Road, Brookline, MA 02146

Electronic Design, biweekly, $25
50 Essex Street, Rockelle Park, NJ 07662

Electronic Engineering Times, 26 times/year, $8
280 Community Drive, Great Neck, NY 11030

Electronic News, weekly, $9.50
7 East 12th Street, New York City,NY 10003

Electronic Technician/Dealer, monthly, $6
757 Third Avenue, New York City, NY 10017

Electronics, biweekly, $12
1221 Avenue of the Americas, New York City, NY 10020

Engineering Education, 8 times/year, $20
One duPont Circle, Suite 400, Washington, DC 20036
(American Society for Engineering Education)

IEEE Spectrum, monthly, $3
345 East 47th Street, New York City, NY 10017
(Institute of Electrical and Electronics Engineers)

Instrumentation Technology, monthly, $7
400 Stanwix Street, Pittsburge, PA 15222

Instruments and Control Systems, monthly, $25
P.O. Box 2025, Radnor, PA 19089

Journal of the Association for Computing Machinery, quarterly,
$30, 1133 Avenue of the Americas, New York City, NY 10036

Machine and Tool Blue Book, monthly, no price listed
Hitchcock Building, Wheaton, IL 60187

Machine Design, 31 times/year, $20
Penton Plaza, 1111 Chester Avenue, Cleveland, Oh 44114

Manufacturing Engineering and Management, monthly, $8.50
20501 Ford Road, Dearborn, MI 48128

Mechanical Engineering, monthly, $10
345 East 47th Street, New York City, NY 10017

Physics Today, monthly, $12
335 East 45th Street, New York City, NY 10017

Process Design, monthly, no price listed
221 Columbus Avenue, Boston, MA 02116

Production, monthly, no price listed
P.O. Box 101, Bloomfield Hills, MI 48013

Tooling and Production, monthly, $10
5821 Harper Road, Solon, OH 44139

Hewlett-Packard Journal
3000 Hanover Street, Palo Alto, CA 94303

Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of the Educational Amendments of 1972 and Title II of the Vocational Education Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.

Employees, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.

The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy.

Title II - Ann Lary, Vocational Equity Coordinator
Title VI - Peyton Williams Jr., Associate Superintendent
of State Schools and Special Services
Title IX - Myra Tolbert, Coordinator
Section 504 - Jane Lee, Coordinator of Special Education

Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, Twin Towers East, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.

Program Improvement and Evaluation
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1984

UPD 3147/8-84